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MULTI-MEDIA DETAILED GEOCHEMICAL STUDY OF THE CANFIELD CREEK Cu-Ag DEPOSIT NORTH-CENTRAL NOVA SCOTIA NOVA SCOTIA DEPARTMENT OF NATURAL RESOURCES

OPEN FILE REPORT 92-003

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ABSTRACT

A detailed multi-media geochemical study was conducted over the Canfield Creek Cu-Ag deposit of north-central Nova Scotia during the 1990 field season. A series of 10 trenches were excavated at 100-250 m spacing along a NS-trending road over the deposit. Till samples were collected at approximately 1-2 m intervals in each trench. In addition to the trenching program, 20 reconnaissance sample sites were established in a 50 km² area around the deposit. Samples collected at each site included: (1) Balsam fir (Abies balsamea); (2) A_o horizon (organic humus) soil layer; and (3) unweathered(?) till taken below the B soil horizon. Samples of humus and Balsam fir were also collected at each trench site, when available.

Several media were submitted for multi-element analysis by the Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) method. These include: (1) -230 mesh (-62.5μm) fraction of till; (2) non-magnetic heavy mineral separates from the -60+230 mesh (-250+62.5 μm) fraction of till; (3) ashed Balsam fir; and (4) -80 fraction of A_o soil horizon. Analytical results are presented in a series of tables. Analytical results for Cu, Pb, Zn and Ag are plotted in a series of figures. To facilitate interpretation of data, cumulative probability plots are presented for these elements for each sample media.

Our data indicate that the Canfield Creek deposit lacks a robust geochemical signature. However, slight negative anomalies (>10 km²) for Cu, Pb and Zn in humus and Pb and Zn in Balsam fir were noted over the deposit. These patterns correspond to an area of Eatonville till that contains up to 90-100% red sandstone clasts.

Three trenches located south of the deposit have slight Cu-enrichment (positive anomaly ?). These samples also have increased percentages of grey sandstone clasts and are interpreted as resulting from glacial dispersion of Cu-enriched grey sandstone.

Despite the subtle geochemical signature of the Canfield Creek deposit, a composite exploration strategy has been developed on the basis of the results of this study. Geochemical exploration for future Cu-Ag deposits in the Cumberland Basin should employ a sequence of biogeochemical, organic humus and till sampling procedures coupled with follow-up trenching in targeted areas.

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1 PROJECT OUTLINE AND INTRODUCTION

The prerequisite for any exploration geochemical survey is the estimation of the geochemical response of mineral deposits in the specific physiographic terrane(s) to be surveyed. This is normally accomplished by orientation or detailed surveys designed to "determine the optimum field, analytical and interpretive parameters which can distinguish an anomaly from background" (Levinson, 1974). The Nova Scotia Department of Natural Resources (formerly Mines and Energy) and the Geological Survey of Canada have conducted 13 separate geochemical surveys in Nova Scotia since 1957 (Rogers and Lombard, 1990). However, only limited orientation surveys have been performed for biogeochemical (Fortescue and Hornbrook, 1969; Brooks et al., 1981), stream sediment (Rogers and MacDonald, 1984a; Rogers and Mills, 1986) and glacial till (DiLabio, 1982; MacEachern and Stea, 1985) sample media. Consequently, the follow-up geochemistry project was initiated as part of the 1990-1992 Canada-Nova Scotia Cooperation Agreement on Mineral Development. The objectives of the project are to: (1) establish the geochemical signature or "fingerprint" of various mineral occurrences throughout Nova Scotia; (2) evaluate the relative effectiveness of various geochemical techniques, including cost; (3) present information that will assist in the interpretation of data from "regional" surveys. This report outlines the results of a study conducted at the Canfield Creek Cu-Ag deposit (Lat. 45° 48' Long. 63° 40') during the 1990 field season.

Detailed geochemical surveys may employ several sampling media including bedrock, till, "B" horizon soil, "A" horizon humus, biogeochemical (i.e. trees and shrubs) and stream sediments or waters. The specific choice of media is determined by the relative availability in the potential survey area. Detailed surveys also typically employ multiple sample preparation procedures, for example various size fractions and/or heavy mineral concentrates may be extracted from stream, till or soil samples. Detailed surveys may also experiment with the relative sensitivity, accuracy and precision of various analytical procedures bearing in mind the type of mineral deposit to be studied. Survey results are used to establish the most efficient and cost effective methods for conducting larger scale surveys.

Several criteria should be considered when selecting a deposit for study. An understanding of the geological setting including the host rock(s), factors controlling mineralization and the essential ore mineralogy and geochemistry of the deposit is essential. It is preferable that the deposit be of economic importance although smaller occurrences can be used. The deposit should subcrop or outcrop such that secondary (i.e. surficial) dispersion has occurred. A fundamental understanding of the glacial geology, including the stratigraphy, provenance and ice flow direction of individual till sheets, if more than one is present, is preferable. Contamination from mining or other human activities must be minimal, such that the natural geochemical pattern or fingerprint can be determined. Lastly, the physiography and geological setting around the deposit must be representative of all, or a portion, of the regional survey area.

2 CANFIELD CREEK Cu-Ag DEPOSIT

2.1 Regional geology

The Canfield Creek deposit is situated in the central portion of the Cumberland Basin (3600 km^2) of north-central Nova Scotia (Fig. 1). The Cumberland Basin extends from Chignecto Bay eastward to the Northumberland Strait near Antigonish. The Cumberland Basin forms the western extension of the larger Maritimes Basin (Williams, 1974). The Cumberland Basin has an east-west structural trend that parallels the adjacent, Hadrynian-Devonian aged Cobequid Highlands (Ryan, 1988).

In general, the stratigraphy of the basin consists predominantly of coarse continental clastic sediments with one major sequence of marine evaporites. More specifically, the basin contains a basal sequence of early Carboniferous, coarse clastic sediments of the Horton Group that are disconformably overlain by an early Carboniferous sequence of chemical sediments (limestone, dolomite) and evaporites (salt, gypsum and anhydrite) of the Windsor Group. The Windsor Group is conformably overlain by a series of red, fine to coarse clastic sediments of the early to late Carboniferous Mabou Group which are in turn overlain by a conformable sequence of grey or green (minor red) coarse clastic sediments of the late Carboniferous Cumberland and Pictou Groups (Ryan and Boehner, 1986). The central portions of the Cumberland Basin are pierced by a series of diapiric evaporite domes.

2.2 Mineral potential of the Cumberland Basin

The Cumberland Basin is host to numerous polymetallic base metal deposits and occurrences that are mostly located within the Pictou Group strata of the Tatamagouche syncline (Ryan, 1988). Chatterjee (1983) concluded that this central part of the Cumberland Basin represented a Cu$\pm$Ag metallogenic domain. Ryan (1988) proposed that the mineral occurrences in this area can be grouped into 3 major types that included:" (1) redbed solution front (Naciemento [e.g. Canfield Creek]) type Cu, Ag, Zn, Pb, Au, U stratiform occurrences of diagenetic origin found proximal to reduction zones; (2) fault-related occurrences such as barite and celestite veins; and (3) Kuperschiefer type (redox) Cu-Ag occurring where carbon-rich strata overlie thick redbed sequences". Ryan (1988) concluded that there was good economic potential for deposits of this type and also alluded to potential for additional sandstone-hosted (e.g. Yava), carbonate-hosted (i.e. Mississippi Valley type) and fault-related, carbonate-hosted (Irish type) deposits in the Cumberland Basin. A schematic diagram summarizing the potential mineral occurrences in the Cumberland Basin is given in Figure 2 (from Ryan, 1988).

2.3 Geology of the Canfield Creek deposit

The Canfield Creek deposit is located approximately 5 km south of the town of Pugwash. The entire area was recently re-mapped by Ryan et al., (1990) at a 1:50 000 scale as part

of a detailed mapping program that covered the entire Cumberland Basin. The geology of the study area is given in Figure 3. The deposit is situated approximately 50-100 m east of a small Windsor Group evaporite dome (1.2 x 1.6 km) within strata of the Malagash Formation of the Cumberland Group. These strata generally dip at <10° NE to the northeast of the deposit but may have dips in excess of 25° near the dome.

The Canfield Creek deposit was discovered during a "wildcat" exploration diamond-drilling program conducted by ESSO Minerals Ltd. (O'Sullivan, 1981). An intersection of 8.1 m of mineralized grey sandstone grading 0.53% Cu was encountered in DDH#P1. Following the discovery of chalcocite in grey sandstones, a 27 hole follow-up drilling program delineated an ore zone with projected reserves of 300 000 tons at 1.2% Cu and minor amounts of Ag (O'Sullivan, 1981). A plan map of this drilling program and a cross-section through the deposit are given in Figure 4. The mineralization occurs at an approximate depth of 100m from surface over an interval of approximately 5 m in thickness and, to date, remains open in two directions. The ore zone consists primarily of chalcocite which occurs as disseminations and nodules ($\leq$3 cm) and as "wispy infillings" along parting planes (O'Sullivan, 1981). Chalcocite often occurs as a replacement of pyrite and/or bornite nodules and minor amounts of digenite and covellite have been reported (Ryan et al., 1989).

The Canfield ore zone is located at the boundary between red and grey sandstone and mudstone strata (Ryan, 1988). There is no apparent change in the style of sedimentation across the red-grey boundary (Turner, 1980). Based on these points and other mineralogical features Ryan (1988) concluded that the reddening of the Pictou strata is of diagenetic origin. The model that he favoured for the origin of the Canfield deposit involves the downward migration of oxygenated waters, probably from the Cobequid Highlands, into permeable Pictou Group sediments. This occurred near the Permian-Triassic transition when the water table was presumably lowered substantially. The oxygenated waters removed and transported metal ions (e.g. Cu, Ag) and deposited these ions near the redox (i.e. red/grey) boundary and in carbon-rich strata, such as channel sandstones, where reducing conditions prevailed.

Several factors make the Canfield Creek deposit a suitable candidate for follow-up geochemical study. These include: (1) there has been no development related activity associated with the deposit and, consequently, there should not be any contamination near the deposit; (2) the diamond drill hole data (O'Sullivan, 1981) provides sufficient information to project the approximate subcrop of the strata that host the deposit, although it is unclear whether these beds are mineralized at surface; (3) the entire area is blanketed by a single till sheet that was deposited by south or southwest ice flow (Stea et al., 1988; see discussion below). Therefore, if glaciation of mineralized sandstone from the deposit occurred, the resulting dispersion would be in either of these directions.

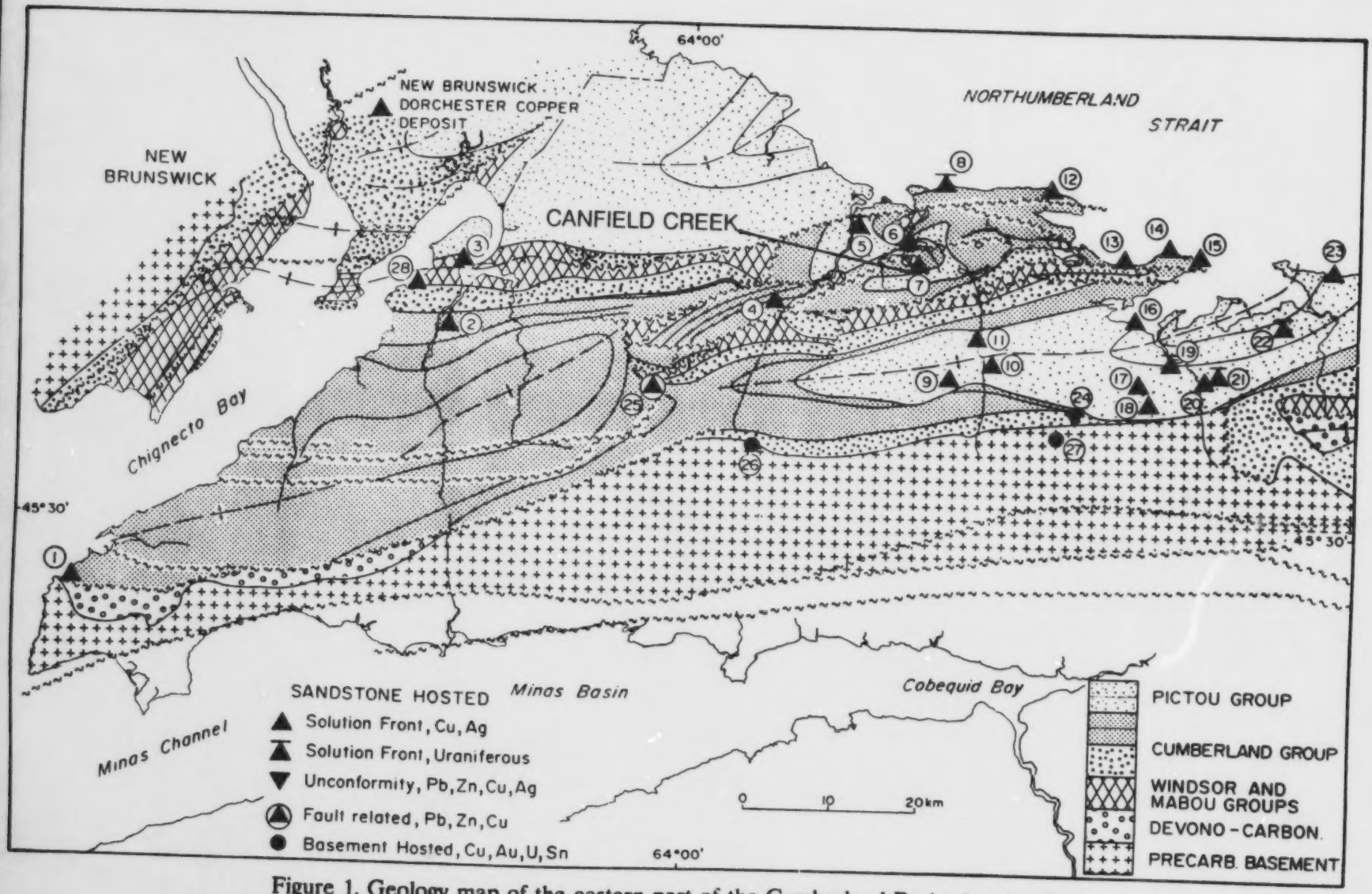

Figure 1. Geology map of the eastern part of the Cumberland Basin showing the location of the Canfield Creek Cu-Ag prospect and other mineral occurrences (modified from Ryan and Boehner, under review; see their text for an explanation of the mineral occurrence numbers).

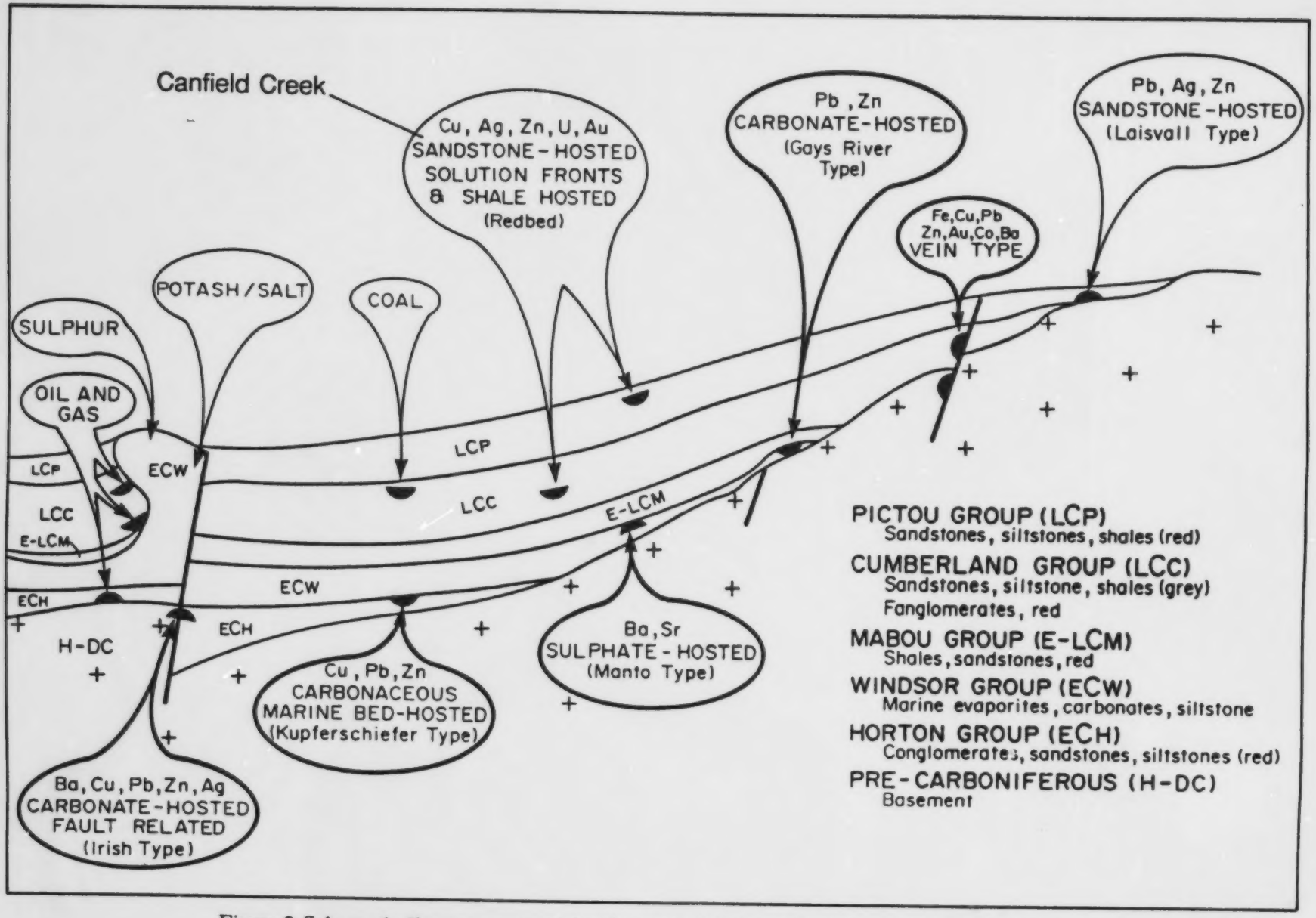

Figure 2. Schematic diagram summarizing the potential mineralization types which may occur in the Cumberland Basin (modified after Ryan and Boehner, under review).

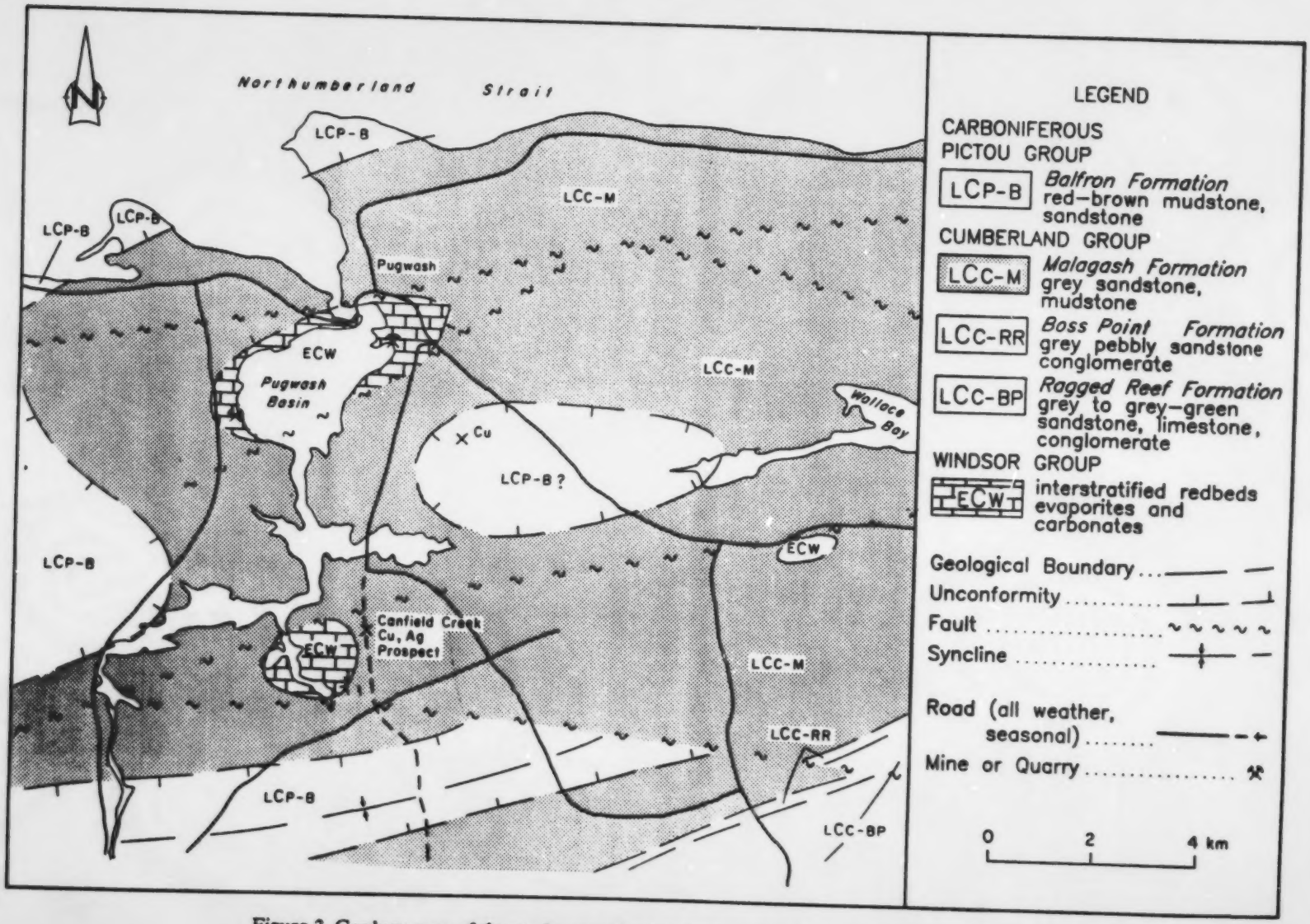

Figure 3. Geology map of the study area showing the location of the Canfield Creek deposit (modified from Ryan et al., 1990).

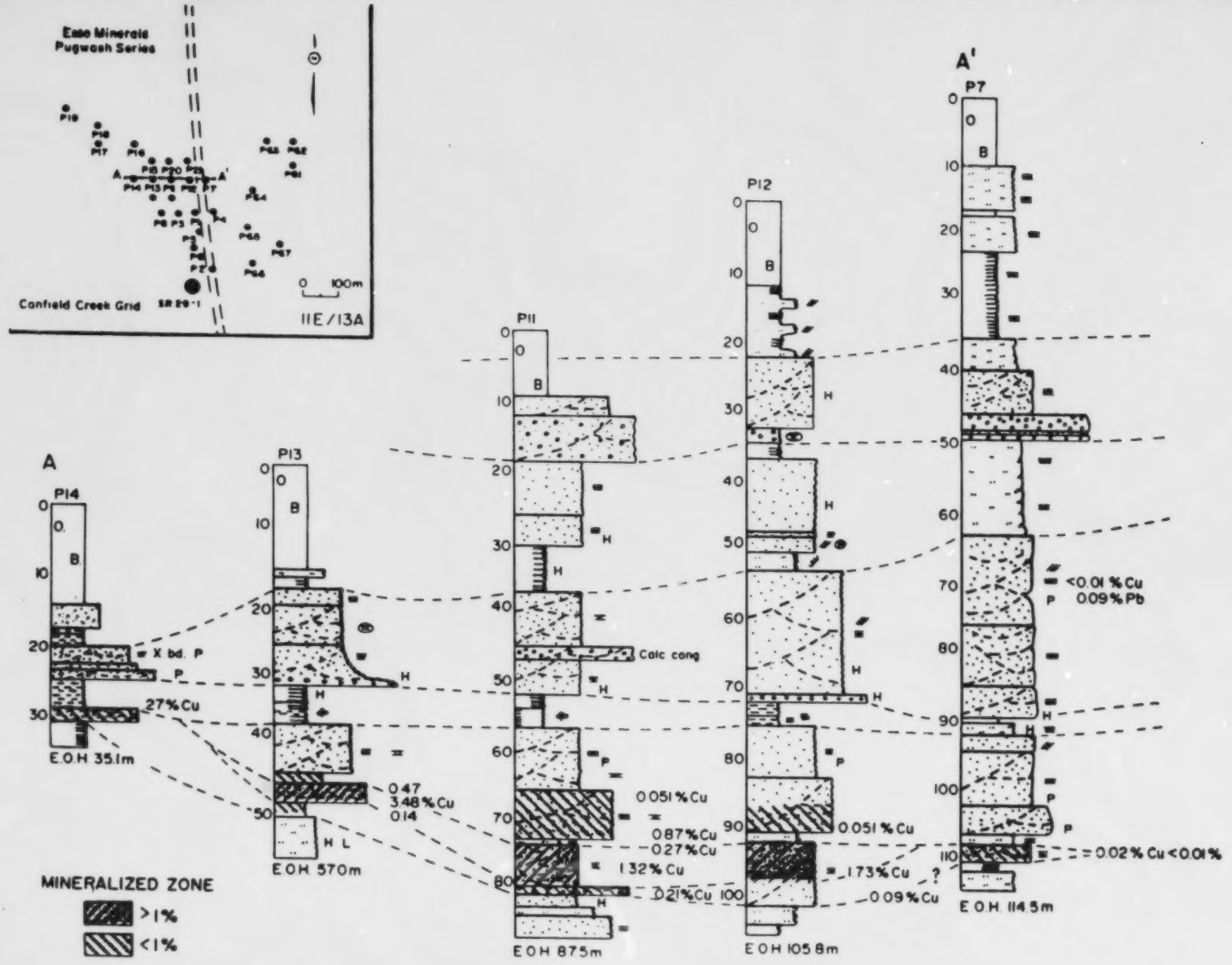

Figure 4. Plan map and cross-section from the ESSO Minerals Ltd. diamond drilling program (O'Sullivan, 1981; modified from Ryan, 1988).

3 PREVIOUS EXPLORATION GEOCHEMICAL STUDIES

3.1 Regional stream sediment surveys

The streams in the study area were first sampled by Holman (1959a,b,c,d) as part of a regional survey covering northern mainland Nova Scotia. Sample collection and preparation techniques and analytical methods are given in Boyle et al. (1963). Means, ranges and cumulative frequency curves were calculated for Cu,Zn,Pb and total soluble heavy metals (i.e.Cu+Zn+Pb) for 12 major rock types in northern Nova Scotia. Ranges and means (in ppm) for catchment basins that overlie Pennsylvanian strata included: Cu -<2-60, av. 6; Pb - <3-190, av. 12; Zn - <5-500, av. 70.

Many of the streams in the study area were sampled including the Canfield Brook itself, which was sampled in 3 locales. One sample was collected approximately 2 km to the southwest of the deposit, immediately above the area affected by tides. Geochemical analysis of the streams in the area returned <5-15 ppm Cu, <60-100 ppm Zn, <10-20 ppm Pb and <5 ppm total soluble heavy metals (Holman, 1959a,b,c,d). The only samples in the entire Canfield Creek catchment basin with elevated levels of heavy metals, compared to the above mean concentrations, include: a sample taken 3 km north of Conns Mills with 40 ppm Cu; a sample on Dochertys Brook, near Pugwash Junction with 16 ppm Cu; and a few samples with 20-25 ppm Pb, none of which were collected proximally to the deposit. In general, the work of Holman (1959a,b,c,d) delineated a few areas throughout the Cumberland Basin that contained slight enrichment in base metals. However, the data did not suggest the presence of Cu$\pm$Ag$\pm$Zn mineralization at Canfield Creek.

The next regional stream sediment survey that covered the study area was conducted as part of a larger survey of the entire northern mainland Nova Scotia and Cape Breton Island under the 1981-84 Canada-Nova Scotia mineral Development Agreement. Sampling and sample preparation procedures are given in Rogers and MacDonald (1984b). Analytical data for 13 elements that were determined by Atomic Absorption Spectrometry are given in Rogers and MacDonald (1986). In many instances, samples were actually collected at approximately the same location as in the survey of Holman (1959a,b,c,d). Rogers and MacDonald (1986) present basic statistics including ranges, means, standard deviations, cumulative frequency curves and histograms for all elements. The means, in ppm, for Cu, Pb, Zn, As and Ag are 7, 14, 55, 2.4 and 0.1 respectively. The sample taken on Canfield Brook, approximately 2 km southwest of the Canfield deposit had slight enrichment in Cu (9ppm), Pb (21 ppm), Zn (90 ppm), U (4.3 ppm) and As (12.0 ppm) when compared to the respective means for the map sheet.

The data from Rogers and MacDonald (1986) is presented as a series of computer-generated contoured plots in Lombard (1991). Contour intervals were determined using percentiles for the entire northern Nova Scotia data set. Individual plots for Cu, Pb, Zn and Ag for the western and central portions of the Cumberland Basin and nearby Cobequid Highlands were enlarged from Lombard (1991) and are given in Figures 5a to d. Note that

the respective legends were not enlarged because of space limitations on the figures and subsequently some care must be used in determining the exact percentile intervals. To facilitate the interpretation of these plots, a transparent geological overlay has been placed in a pocket at the back of this report.

Perhaps the most striking feature of these plots is the strong contrast in levels of Cu, Pb, Zn and Ag between the Cobequid Highlands and the adjacent Cumberland Basin as previously noted by Bonham-Carter et al. (1985) and Rogers et al. (1986). Within the basin the streams that drain across the three main synclines (Amherst, Tatamagouche and Athol; Ryan and Boehner, under review) generally have lower values of Cu, Pb and Zn when compared to the major anticlines and areas underlain by the lower facies of the Cumberland, Windsor and Mabou groups. The Cu levels in streams near the Canfield deposit mostly range from 25-50th percentile which is similar to much of the northern portion of the Basin. In contrast the streams to the southwest of the deposit have Cu levels in the 50-60th percentile range. It is not clear whether this enrichment in Cu is related to the Canfield deposit. The levels of Pb and Zn in streams near the deposit are slightly higher than the surrounding areas of the Basin (e.g. Pb - 60-70th and Zn - 50-60th %ile compared to <25-60th and 25-50th%ile respectively). The majority of the streams from the Cumberland Basin have Ag levels that are <25th percentile for northern Nova Scotia. One exception is an area 5-10 km southwest of the Canfield deposit where streams have very high Ag values (>95th %ile). In summary the data from the 1982-83 survey of Rogers and MacDonald (1986) do not outline either significant positive or negative Cu or Ag "anomalies" near the Canfield deposit. In contrast there is slight elevation in the levels of Pb and Zn near the deposit.

As part of the 1985-89 Canada-Nova Scotia Mineral Development Agreement, a heavy mineral and silt/clay stream sediment survey was conducted throughout northern Nova Scotia and Cape Breton Island (Mills, 1989). The sample spacing was increased in this survey (1 per 7.5 km^2) compared to 1 per 4.28 km^2 in the survey of Rogers and MacDonald (1984b). Mills (1989) presents analytical data for 27 trace and major elements, including Ag, Zn and U, that were determined by Instrumental Neutron Activation Analysis (INAA). Unfortunately, Cu and Pb were not included in the suite of elements.

The nearest sample to the Canfield deposit was taken on Dochertys Brook, immediately upstream from Pugwash Junction, approximately 4 km away from the deposit. Concentrations of Zn, Ag and most other trace elements were approximately equal to the respective means for the entire 1:50,000 scale map sheet 11E/13. In contrast, several Rare Earth Elements (REE) in this sample were much higher than their respective means. The significance of the enrichment in REE is not clear.

The -230 mesh fraction from the same suite of samples was submitted for analysis by the Directly Coupled Plasma-Atomic Emission Spectrometry (DCP-AES) for a suite of 16 trace elements that included Cu, Zn and Ag. The sample on Dochertys Brook contained values for Cu, Zn and Ag (11, 92 and 0.25 ppm) that were equal to or slightly below the mean for

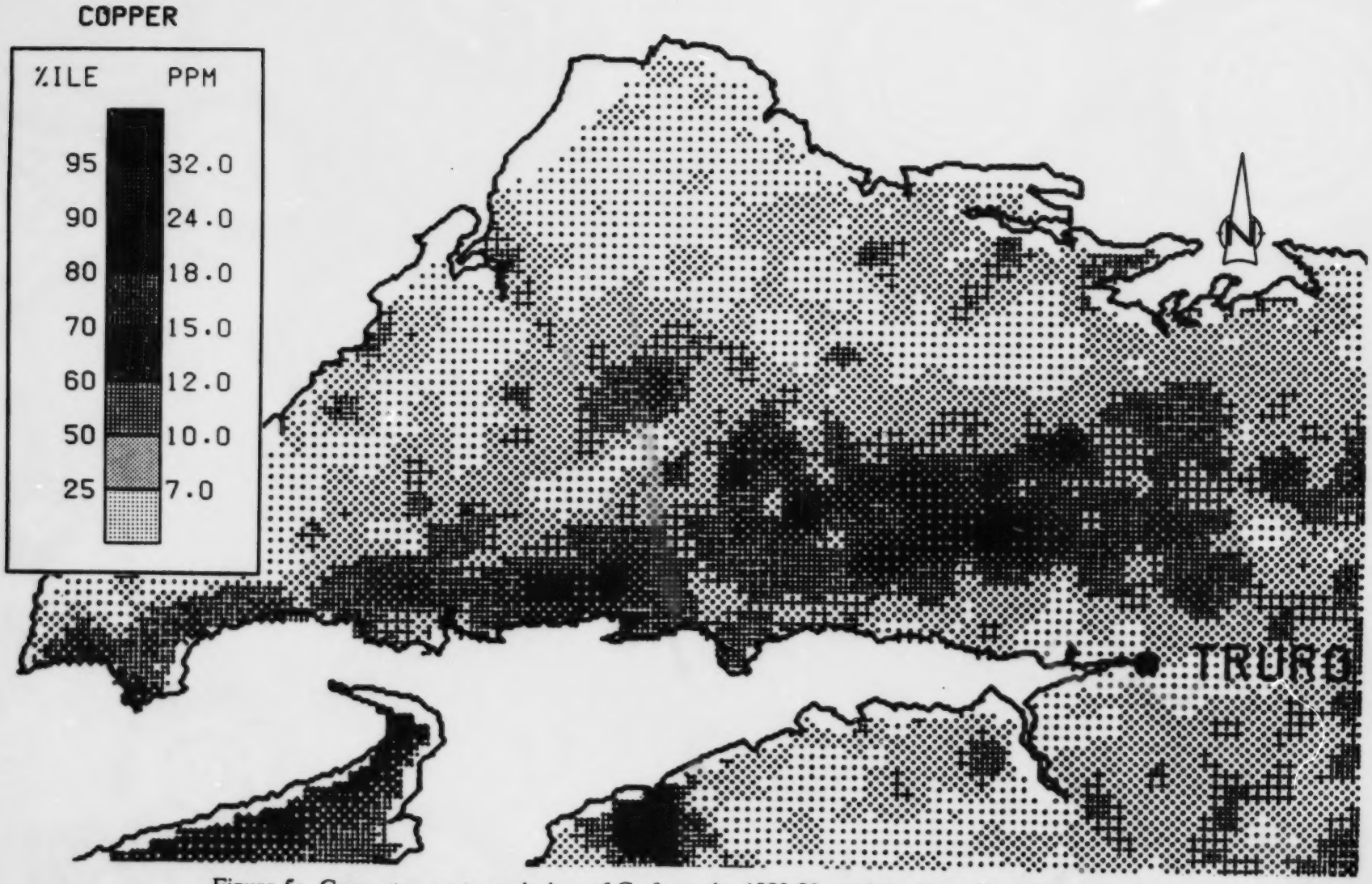

Figure 5a. Computer contoured plots of Cu from the 1982-83 northern Nova Scotia stream sediment (-80 (-177 μm) mesh) survey (Rogers and MacDonald, 1986; modified after Lombard (1991).

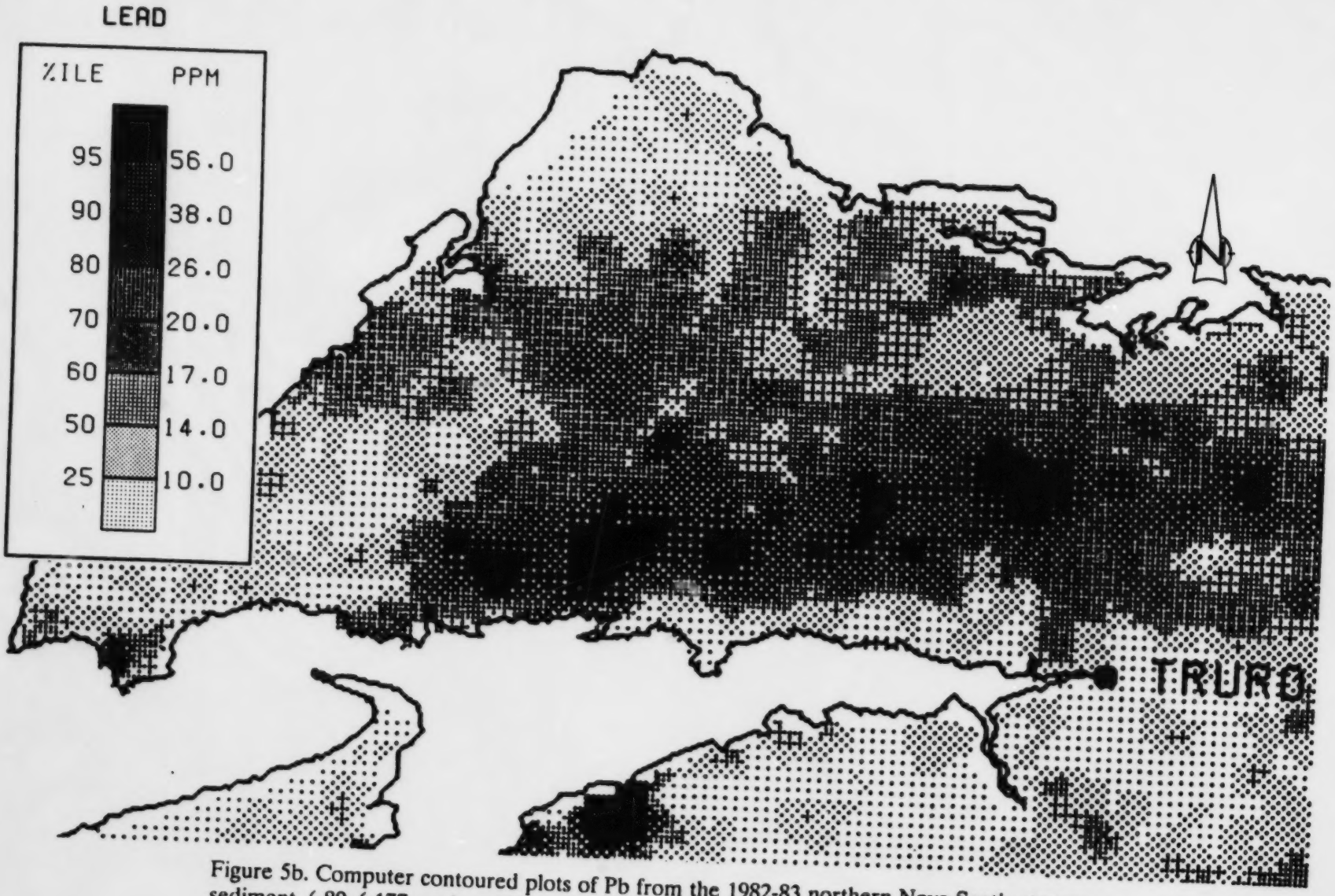

Figure 5b. Computer contoured plots of Pb from the 1982-83 northern Nova Scotia stream sediment (-80 (-177 μm) mesh) survey (Rogers and MacDonald, 1986; modified after Lombard (1991).

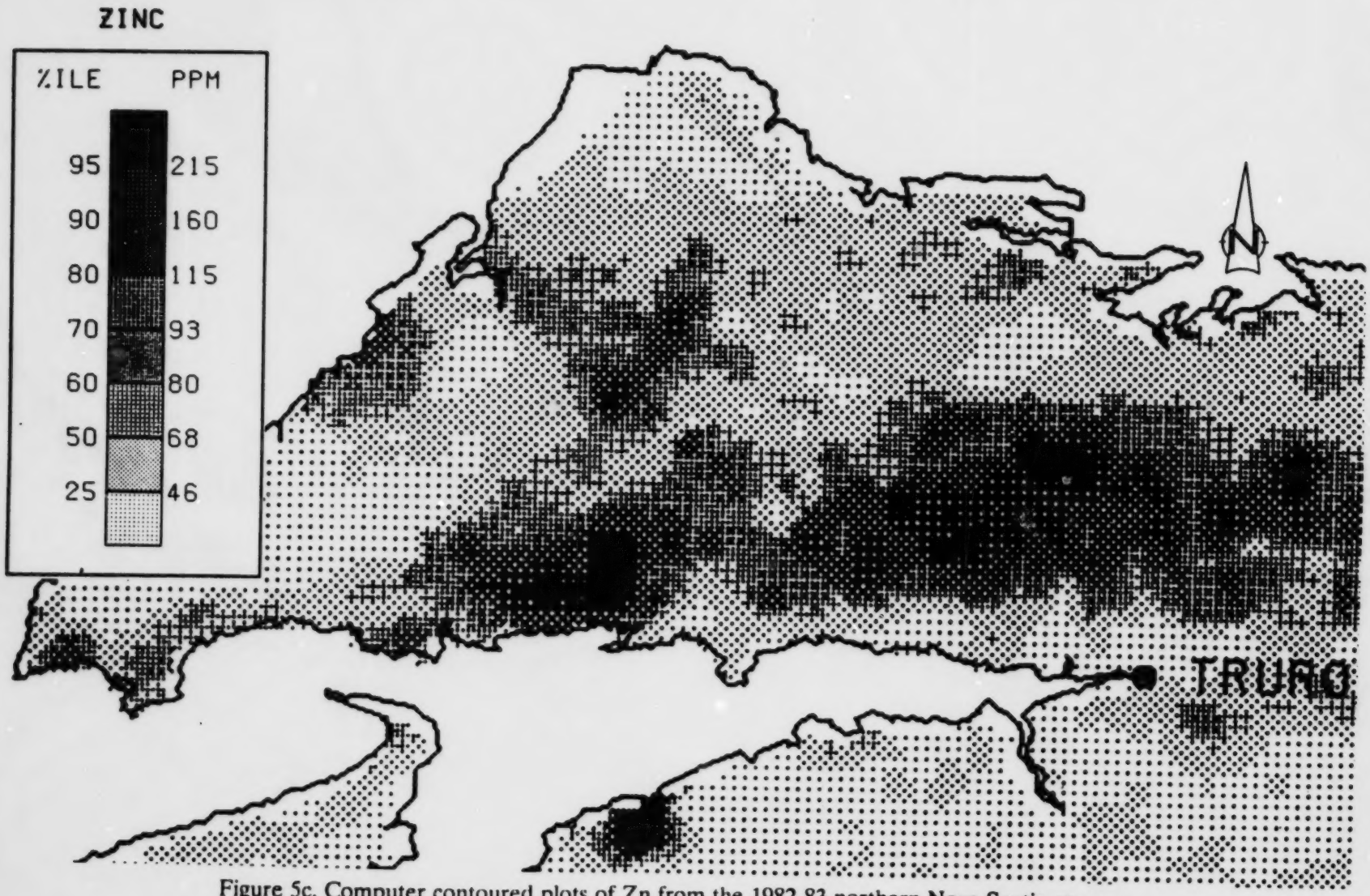

Figure 5c. Computer contoured plots of Zn from the 1982-83 northern Nova Scotia stream sediment (-80 (-177 μm) mesh) survey (Rogers and MacDonald, 1986; modified after Lombard (1991).

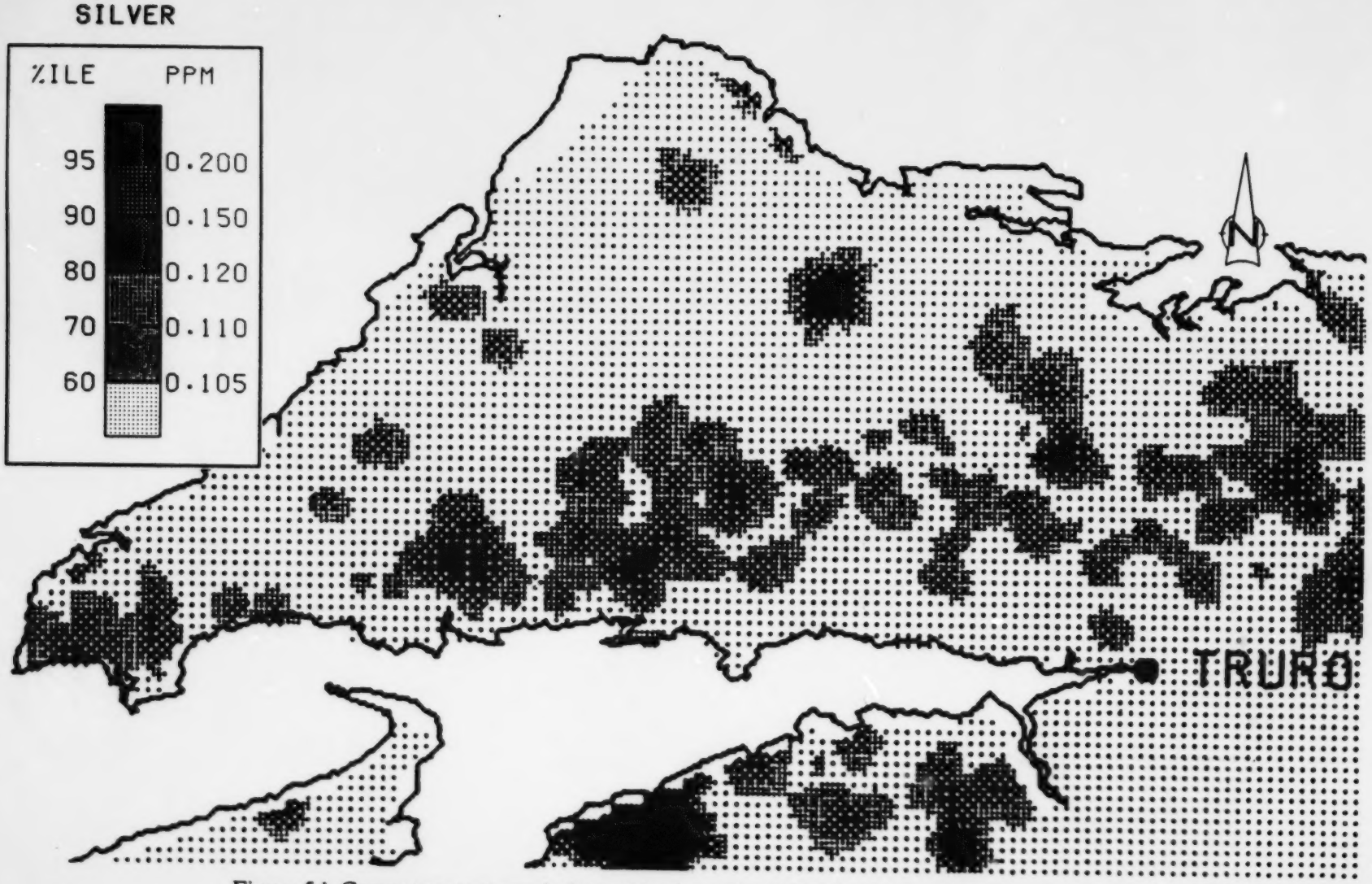

Figure 5d. Computer contoured plots of Ag from the 1982-83 northern Nova Scotia stream sediment (-80 (-177 μm) mesh) survey (Rogers and MacDonald, 1986; modified after Lombard (1991).

the map sheet (19, 94, 0.25 ppm respectively).

The data from Mills (1989) is presented as a series of computer-generated contoured plots in Lombard (1991). Contour intervals were determined using percentiles for the entire northern Nova Scotia data set that includes several geological geological terranes and metallogenic domains. Individual plots for Cu (-60+230 mesh fraction - heavy minerals), Zn and Ag (-230 and -60+230 mesh fractions) for the western and central portions of the Cumberland Basin and nearby Cobequid Highlands are given in Figures 6a to e.

A comparison of Figures 5 and 6 reveals some differences between the 1982-83 and 1986-78 stream sediment surveys. For example, the Cu levels in streams near, and to the southwest of the Canfield deposit are low (<25th %ile) compared with the surrounding parts of the basin. This sharply contrasts the increased levels of Cu from streams in the same area that were analysed in the 1982-83 survey. Secondly, there is no increase in Zn levels in streams near the deposit, in contrast to the 1982-83 survey. The levels of Ag in streams from the Canfield Creek area are consistently low (<25th %ile) which is in agreement with the 1982-83 survey.

There are some large-scale differences between the results of the 1982-83 and 1986-87 surveys. For example, the strong geochemical contrast between the Cobequid Highlands and the Cumberland Lowlands that was shown in the 1982-83 survey is only evident in the Cu plot. In the 1986-87 data the levels of both Zn and Ag are similar for these two geological terranes. The geochemical contrast between the three main synclines (low Cu and Zn) and anticlines (high Cu and Zn) described above, is absent in the 86-87 data. Interestingly, some of the highest Zn values in heavy mineral separates occur in streams along the shoreline in the westernmost part of the basin. The Zn levels in the -230 mesh fraction do not reflect the heavy mineral patterns. A complete discussion of the factors responsible for the observed geochemical differences between the two surveys is beyond the scope of this report but may be due, at least in part, to different sample digestion and analytical techniques. For example, the 1986-87 survey is more prone to "dilution effects" because of the total acid digestion that was employed (Rogers pers. comm.).

In summary, the streams in the Canfield Creek area have been repeatedly sampled as part of regional stream sediment surveys between 1957 and 1986. The geochemical patterns displayed by the various surveys varied substantially, according to the element, sample preparation procedures and the respective analytical techniques. In general there is little, or no, enrichment or depletion in either Cu or Ag in streams from the Canfield Creek area. One exception to this is the low Cu levels in the 1986-87 heavy mineral survey that may represent a "negative Cu anomaly".

3.2 Regional till geochemical surveys

The study area was covered by regional till geochemical survey (Turner and Stea, 1987) at a sample spacing of 1 per 13.12 km^2. The clay fraction (-2000 mesh or -2 μm) was analysed

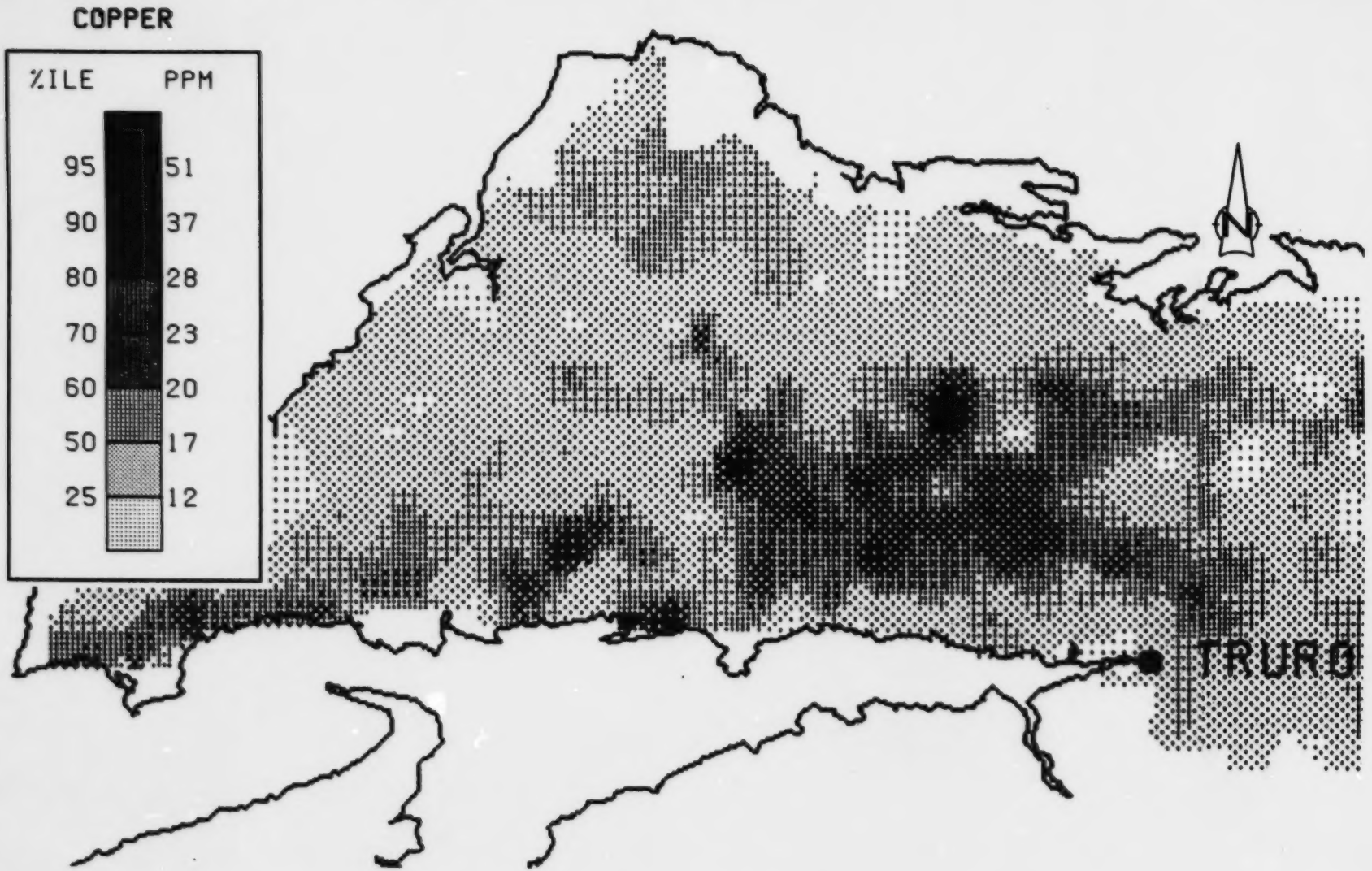

Figure 6a. Computer contoured plots of Cu (-230 mesh fraction) from the 1986-87 northern Nova Scotia stream sediment survey (Mills, 1989; modified after Lombard, 1991).

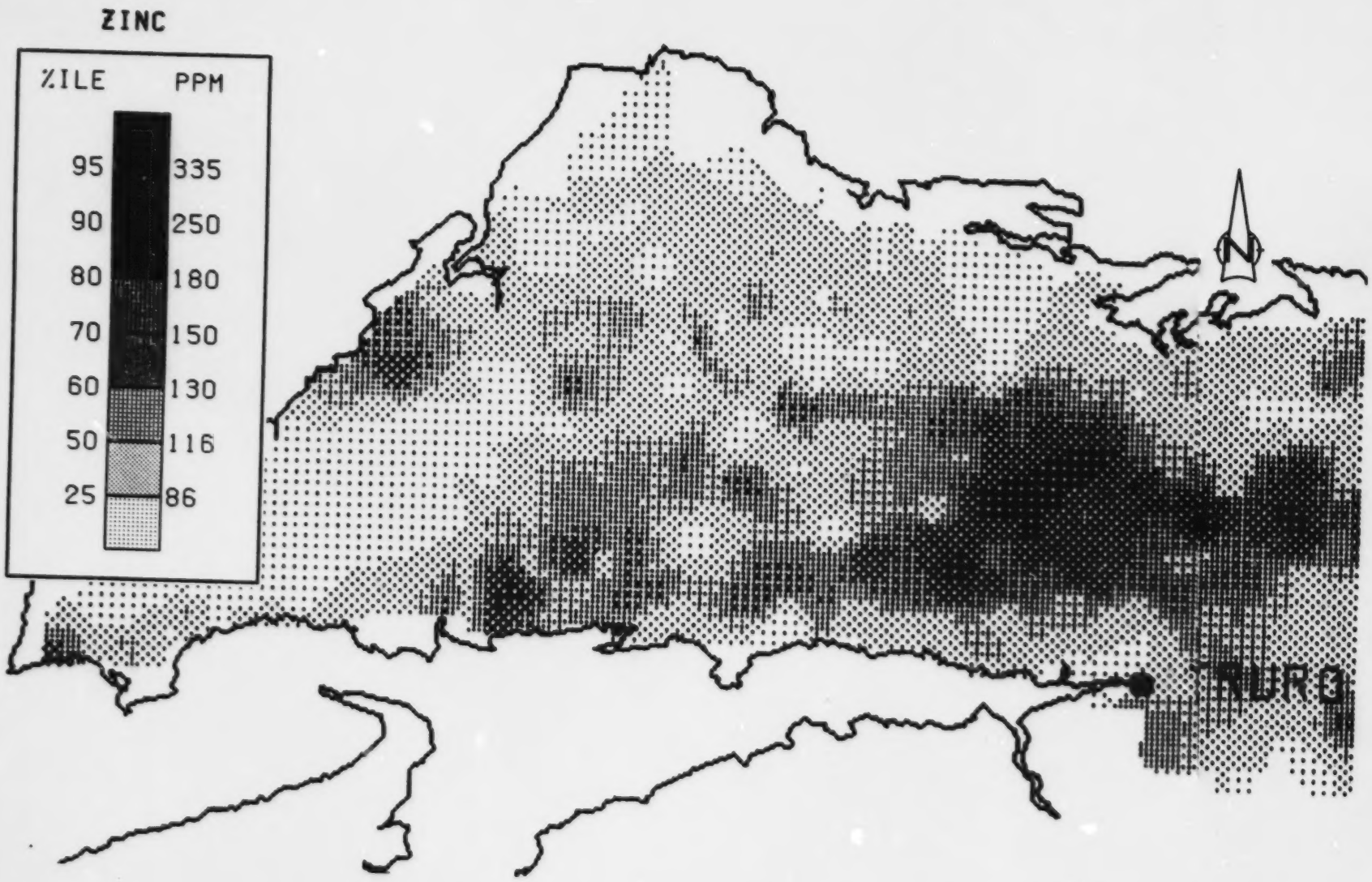

Figure 6b. Computer contoured plots of Zn (-230 mesh fraction) from the 1986-87 northern Nova Scotia stream sediment survey (Mills, 1989; modified after Lombard, 1991).

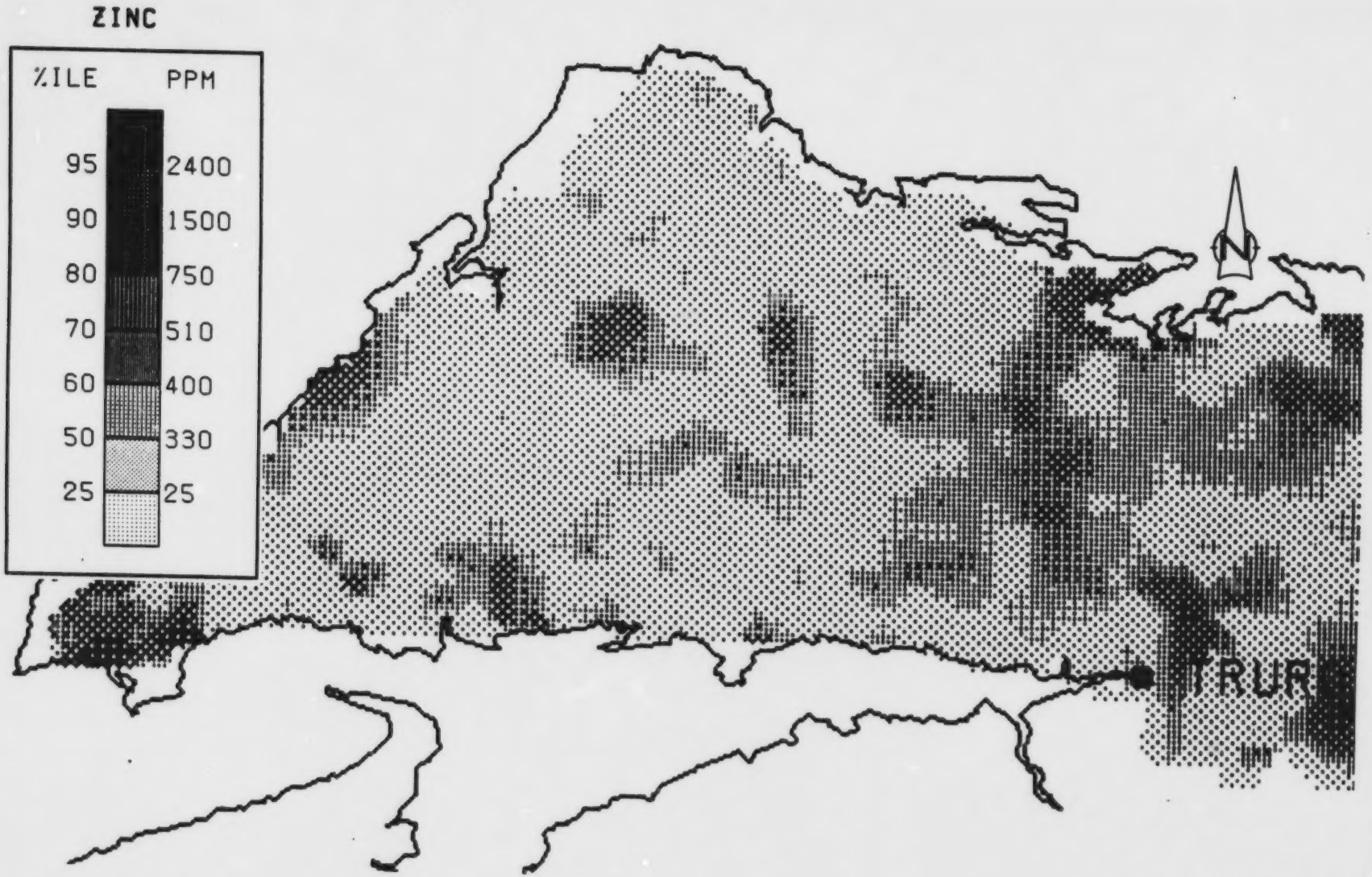

Figure 6c. Computer contoured plots of Zn (-60+230 mesh heavy mineral separates) from the 1986-87 northern Nova Scotia stream sediment survey (Mills, 1989; modified after Lombard, 1991).

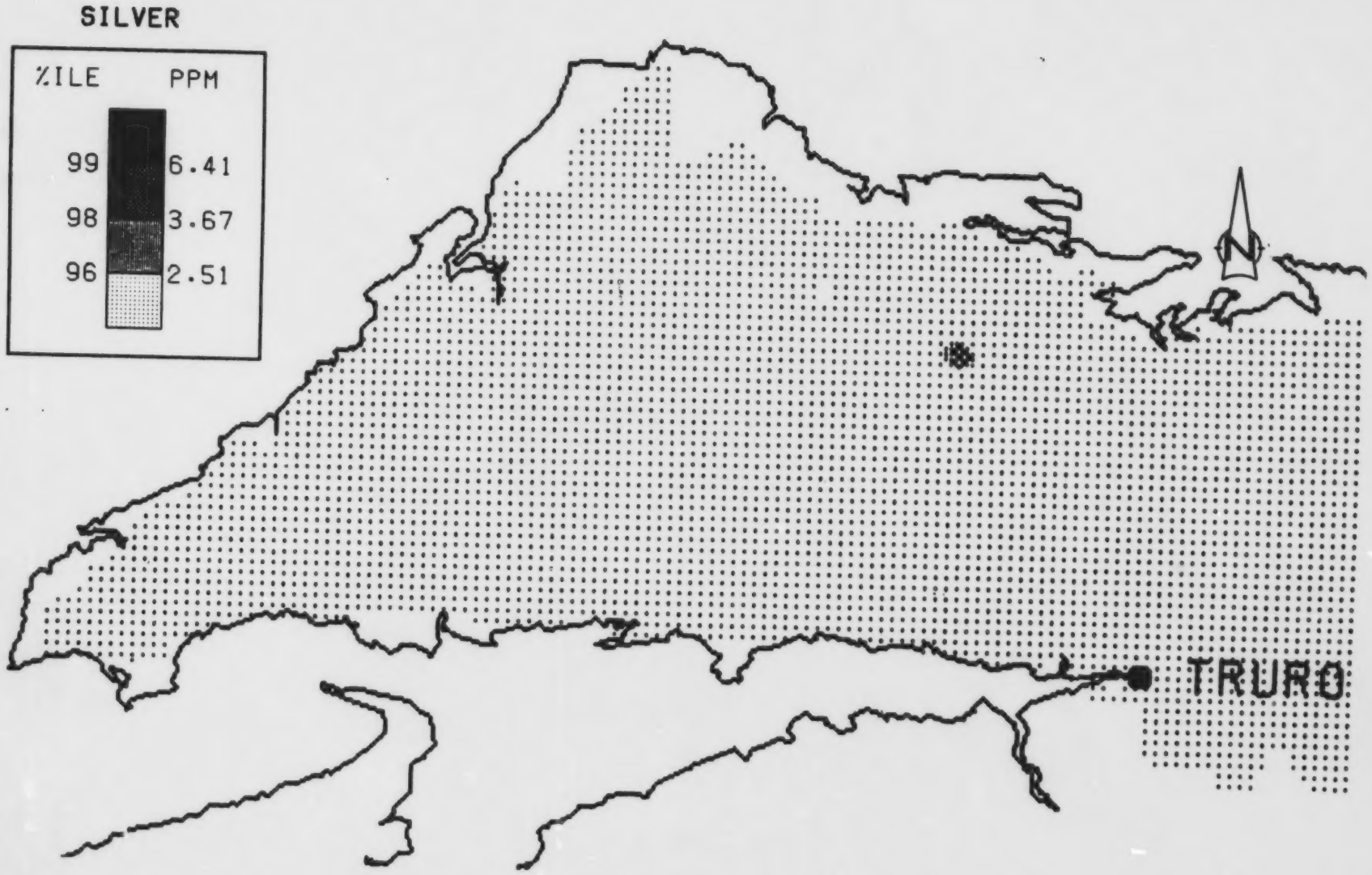

Figure 6d. Computer contoured plots of Ag (-230 mesh) from the 1986-87 northern Nova Scotia stream sediment survey (Mills, 1989; modified after Lombard, 1991).

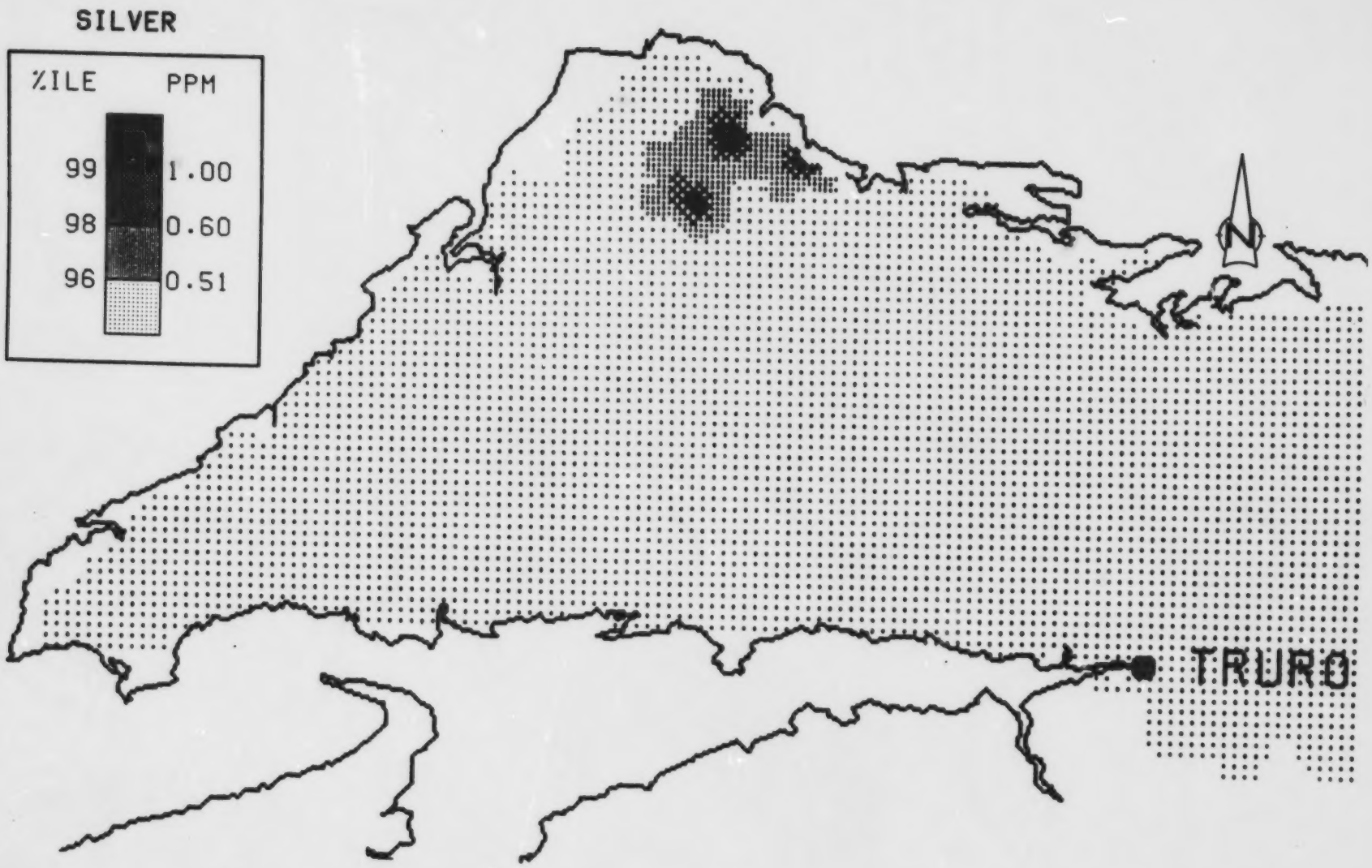

Figure 6e. Computer contoured plots of Ag (-60+230 mesh heavy mineral separates) from the 1986-87 northern Nova Scotia stream sediment survey (Mills, 1989; modified after Lombard, 1991).

for a suite of 17 elements including Cu,Pb,Zn,Ag and U, which are typically associated with sediment-hosted mineralization in the Cumberland Basin. A heavy mineral concentrate from the 62.5-300 μm size fraction of the till samples was analysed for Sn, W and Ba. Analytical technique was Atomic Absorption Spectrophotometry (AA) for all elements except As and W (colourimetry) and U (fluorometry).

Turner and Stea (1987) calculated basic statistics (range, mean, std. dev.) and calculated anomaly levels using thresholds set at the 95th percentile for the 1:100 000 map sheet. Several samples were taken in the vicinity of Canfield Creek (i.e. <5 km) and one sample was collected at the intersection of Crowley and Conns Mills roads, approximately 2 km south of the deposit. A surficial geology map showing the sample locations and accompanying analytical data for Cu, Pb, Zn and Ag are given in Figure 7. Samples with anomalous elemental concentrations (i.e. > 95th percentile) have been denoted.

A few anomalies are shown in Figure 7 although none of the anomalous samples are from the vicinity of, or are presumably related to, the Canfield deposit. For example, a sample with anomalous Cu-U occurs approximately 10 km east of the deposit. Pb-Zn and Cd-U anomalies were noted approximately 10 km north of the deposit. The sample that was collected directly south of the Canfield Creek ore zone is not anomalous in any elements. Values for Cu, Pb, Zn and Ag in this sample were only 25, 28 102 and 0.05 ppm respectively, which were near or significantly below the mean values for the entire sheet (56, 50, 142 and 0.07 respectively). In brief, the till geochemical study of Turner and Stea (1987) was unsuccessful in delineating the Canfield Creek Cu-Ag deposit.

3.3 Detailed soil survey

Following the discovery of the Canfield Creek mineralization by wildcat diamond drilling, ESSO Minerals (O'Sullivan, 1981) conducted a detailed soil survey in an attempt to delineate additional ore zones. A 2 x 2 km grid was centred around the Windsor Group diapir. A total of 312 samples of "B" horizon soils were collected on 100 m centres throughout this area, except over much of the diapir where swampy, karstified terrain prohibited sampling.

Details regarding the sample collection and analytical techniques are given in O'Sullivan (1981). Sample locations and contour plots for Cu and Zn are given in Figures 8a and b. The mean Cu, Pb and Zn concentrations for red and grey tills in the Cumberland Basin are 27,101,27 and 55,145,37 ppm respectively (Stea et al., 1986). It should be stressed that the geochemical response of "B" horizon weathered soil will differ from unweathered till (Levinson, 1977; R. Dilabio, unpubl. data). However, to facilitate discussion the data of O'Sullivan (1981) will be compared to the data of Stea et al., 1986). Only three samples from the detailed survey had Cu values that exceeded the mean for red tills (27 ppm). Accordingly Figure 8a has been contoured using 10 ppm contour intervals to best display the Cu distribution. Eleven samples had Zn concentrations that exceeded the mean for red tills (i.e. 101 ppm) whereas only one had levels that surpassed the mean for grey tills (i.e. 145 ppm). The distribution of Zn is given in Figure 8b. Only 8 samples had Pb levels that exceeded the

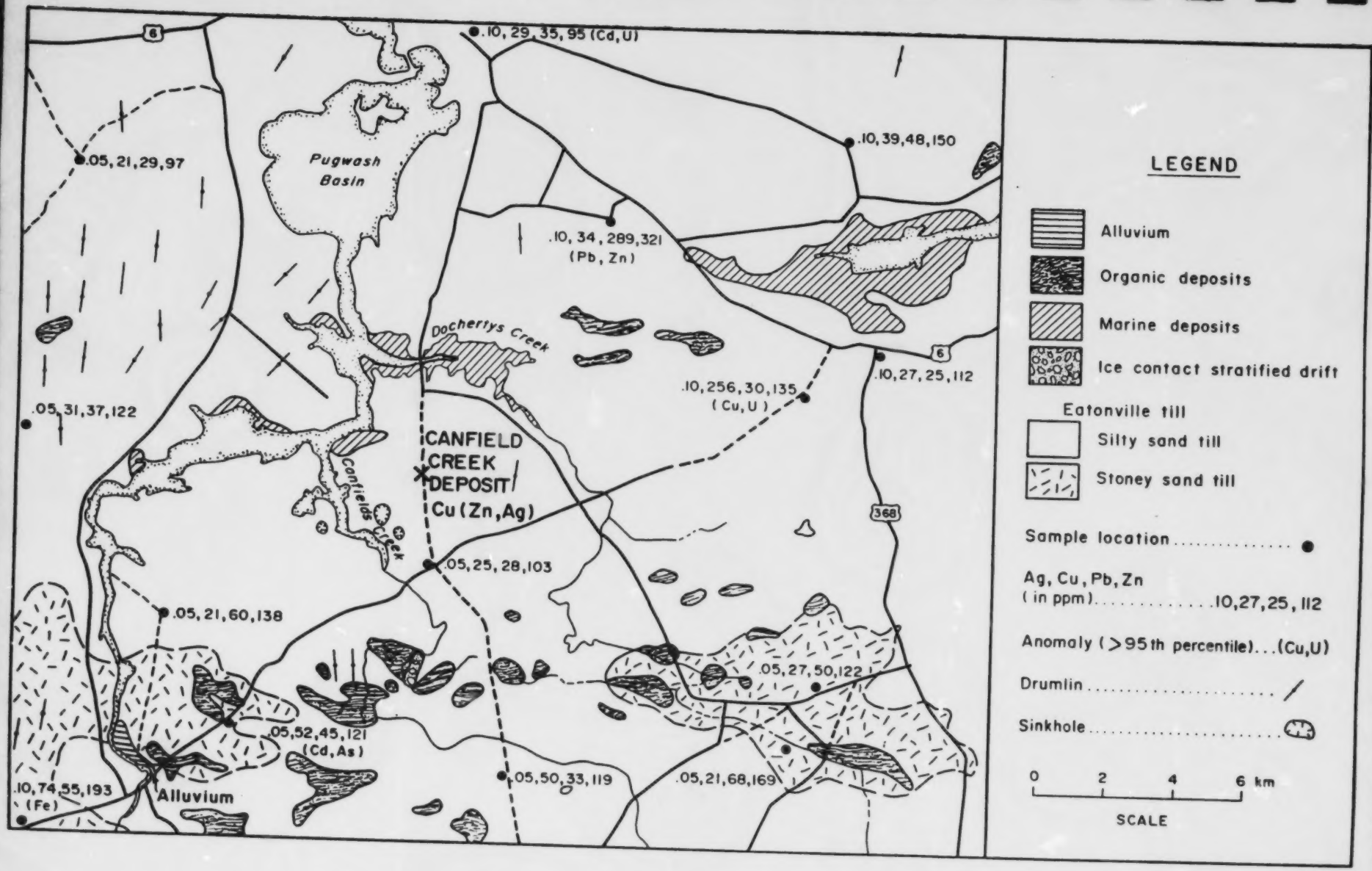

Figure 7. Surficial geology of the study area (modified after Stea and Finck, 1988). Sample locations along with till geochemical data (Cu,Pb,Zn,Ag) from Turner and Stea (1987) have also been plotted.

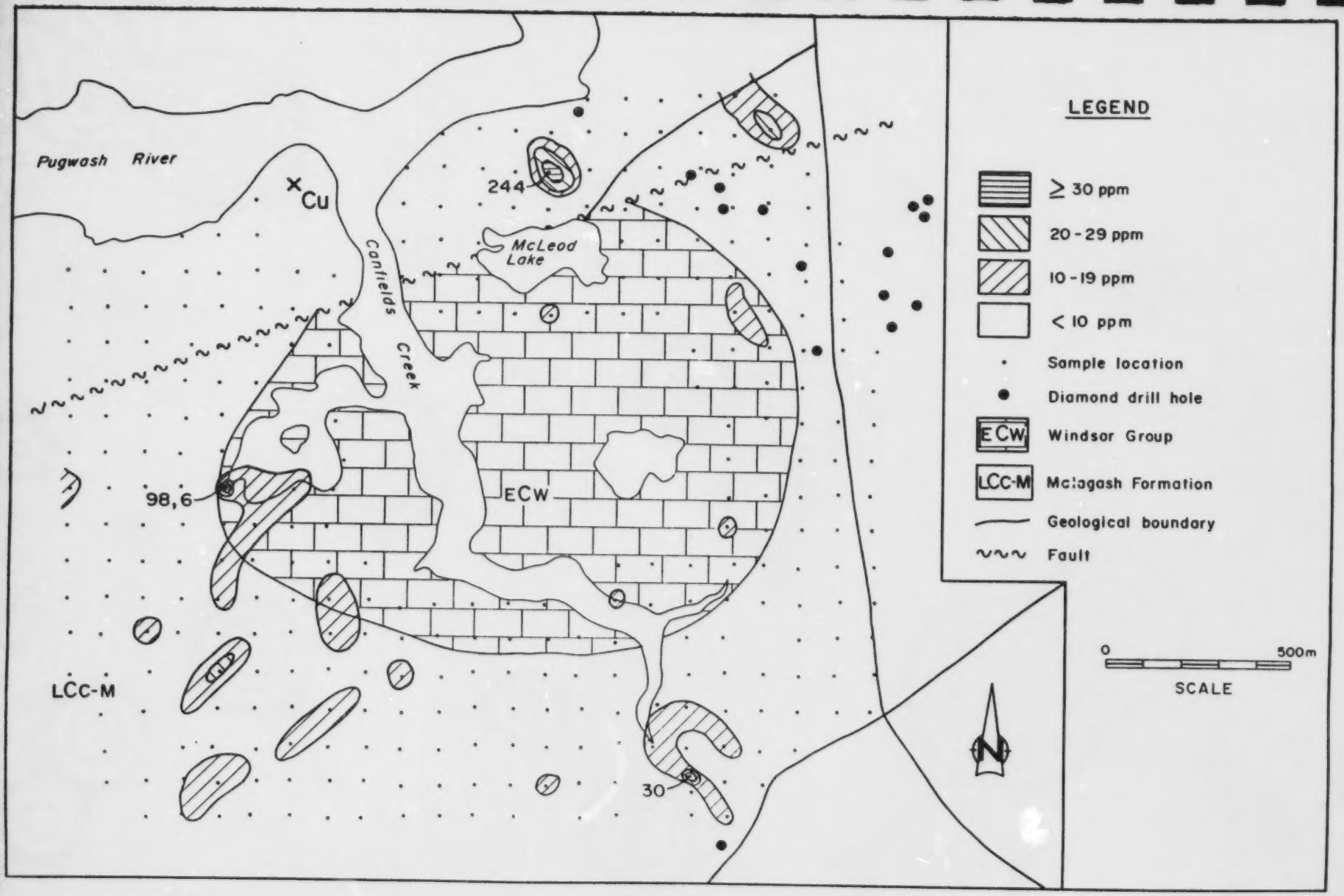

Figure 8a. Contour plots of Cu from a "B" horizon soil survey conducted by ESSO Minerals Ltd. over the Canfield Creek deposit (modified after O'Sullivan, 1981).

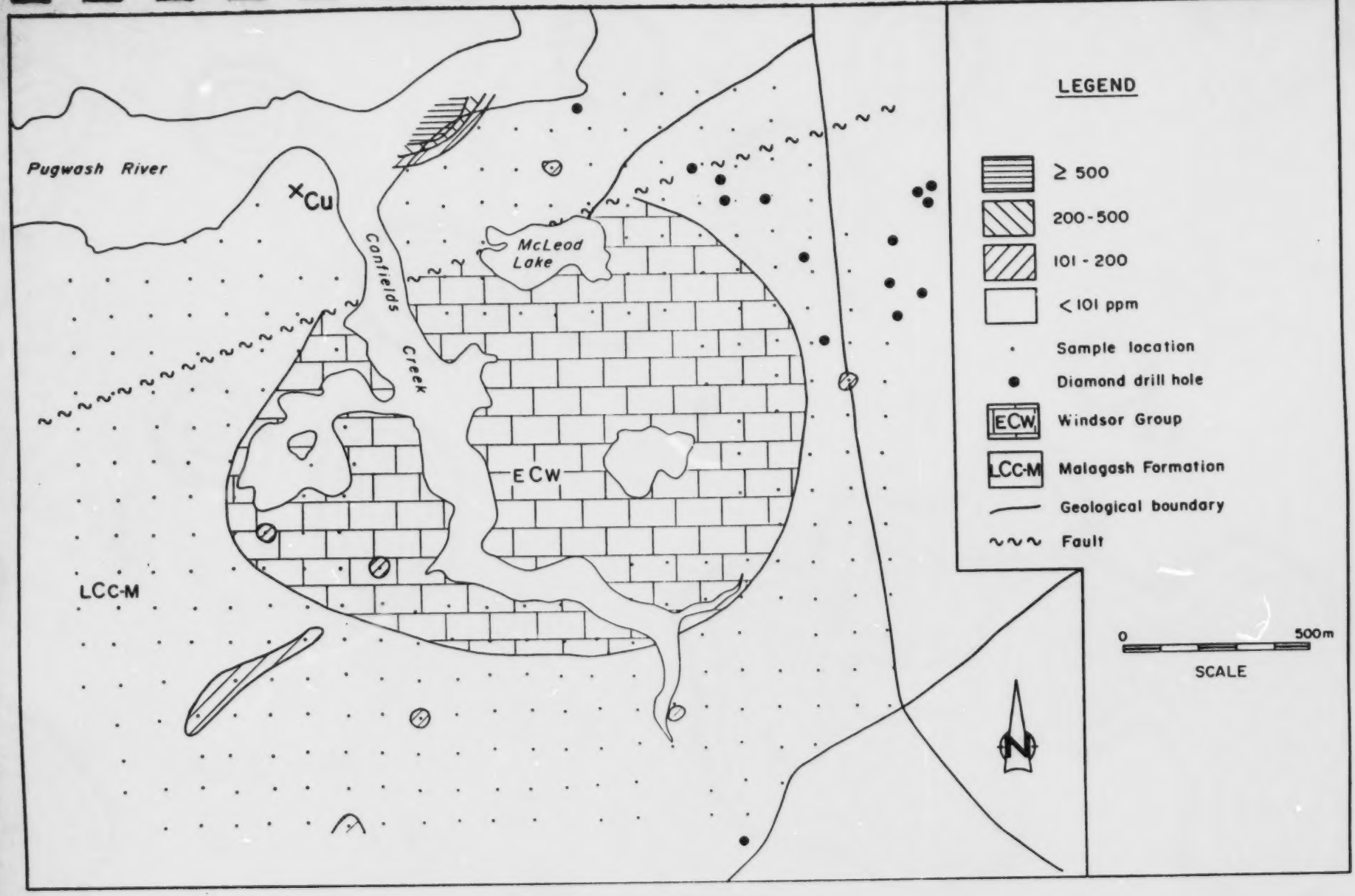

Figure 8b. Contour plots of Zn from a "B" horizon soil survey conducted by ESSO Minerals Ltd. over the Canfield Creek deposit (modified after O'Sullivan, 1981).

mean for red tills (i.e. 27 ppm). The distribution of samples with slight enrichment in Pb is similar to that for Cu and Zn. The data from O'Sullivan (1981) indicate a lack of geochemical response from the Canfield Creek deposit. Small isolated areas with slight enrichment in Cu and Zn do not correspond to the projected subcrop of the mineralized strata but rather are located throughout the grid.

3.4 Exploration model

Several workers including Stea et al. (1986), Ryan (1988) and Ryan et al. (1989) have investigated the geochemical characteristics of till, bedrock and stream sediments in the Cumberland Basin. They noted significantly lower concentrations of Cu in red sandstone and mudstone of the Pictou Group in the Tatamagouche area when compared with grey sandstone and mudstone from the same strata. Similarly, they documented lower Cu concentrations in red sandstone-dominated tills and overlying stream sediments versus grey sandstone-dominated tills and overlying stream sediments from the same area. These workers concluded that the lower Cu levels result from large-scale mobilization of Cu during a reddening (i.e. oxidizing) event that occurred at, or near, the Permian-Triassic boundary. As previously stated in section 2, this process involves the mobilization and deposition of Cu-Ag ore by downward migration of oxygenated water into porous horizons due to a lowered water table.

Exploration geochemical programmes designed to locate Canfield Creek-type deposits (i.e. Naciemento; Ryan, 1988) must consider the above factors. For example if the erosional level within portions of the basin are deep enough to expose mineralized grey strata, the explorationist should search for "positive anomalies" involving Cu and possibly Zn, Ag, U or Au. Conversely, if the erosional level was insufficient to expose mineralized strata the explorationist may have to rely upon the delineation of anomalous elemental depletions within the Cu-depleted red strata, or "negative anomalies", that may overly potential mineralized zones. For a discussion of the concept of "negative anomaly" the reader is referred to Rogers and MacDonald (1984a) The implications of this thesis will be discussed below.

4 SURFICIAL GEOLOGY

The area around the Canfield Creek deposit is typified by a low-lying, gently rolling landscape. The surficial geology of the study area was mapped by Stea and Finck (1988) as part of a 1:100,000 scale surficial mapping programme that covered mainland Nova Scotia. The surficial geology of the study area is given in Figure 7.

The majority of the area is underlain by a reddish-brown silty sand till termed the Eatonville till by Stea and Finck (1988). This till typically forms fluted, drumlinized and gently rolling ground moraine that ranges in thickness from 1-15 m. Locally, in topographic depressions, a stoney and sandy facies of the Eatonville till has been mapped. This facies typically contains a high proportion of distally-derived Cobequid erratics when compared to the main Eatonville till facies. The stoney facies is often associated with deposits of ice-contact stratified drift as noted along the rail-tracks south of Canfield Creek. These deposits have been termed the Apple River member by Stea and Finck (1988). Several areas surrounding brackish lagoons (e.g. Pugwash Basin) contain marine deposits including sand, silt and clay that are locally overlain by peat and organic deposits. Numerous other low-lying areas near Canfield Creek contain organic deposits (e.g. peat, gyttja and clay).

Stea et al. (1988) proposed a series of ice flows for much of the Cumberland Basin, including the study area. In their model, the earliest and most extensive ice flow (Phase #1) was initially eastward and subsequently southeastward. A silty, clast-poor till found at the base of many coastal till sections throughout northern Nova Scotia has been ascribed to this initial (Wisconsinan?) ice flow. Stea et al. (1988) have termed this till the McCarron Brook till in northern Nova Scotia whereas Stea and Fowler (1979) have described a similar till in southern Nova Scotia and called it the Hartlen Till. Stea et al. (1988) proposed that the second major ice flow (Phase #2) in this part of Nova Scotia was to the south or southwest. They concluded that this ice flow deposited the silty-sand till termed the Eatonville till. Finally, the third ice flow in the study area was to the north with ice originating from a local ice centre on the South Mountain area of southern Nova Scotia. This ice flow deposited the stoney facies of the Eatonville till. The majority of the study area, including the immediate area around the Canfield deposit, is underlain by the Eatonville till. Therefore, if the mineralized beds from the Canfield deposit extended to surface and were glaciated by phase #2 ice flow, the resultant dispersion train would likely extend to the south or southwest from the deposit. However, if the Eatonville till is underlain by deposits of the McCarron Brook till, that was deposited by easterly flow (Phase #1), it is possible that some dispersed mineralization from this lower till may be inherited in the upper Eatonville. Therefore, when interpreting geochemical patterns in and around the Canfield Creek deposit, the explorationist must consider the possibility of several directions of glacial dispersion.

5 TRENCH SURVEY

5.1 Introduction

As discussed in section 3, previous regional stream and till surveys did not indicate the presence of positive enrichment in Cu±Zn±Ag near the Canfield Creek deposit. In order to evaluate the possibility of Cu±Ag enrichment in basal sections of the Eatonville till it was decided that a trench survey be conducted over the projected subcrop of the Canfield Creek ore horizon. Wherever possible, samples of Humus, Balsam fir and Red Spruce were collected at each of the trench sites.

An examination of SeaSat Imagery and Infrared photography and, to a certain extent, air photographs in the vicinity of Canfield Creek indicates the presence of numerous linears (R.J. Ryan pers. comm. 1991). These linears are interpreted as resistant sandstone ridges with interbedded mudstone and shale occupying the low-lying areas. The presence of these ridges indicates that the glacial cover over much of the study area does not exceed several metres. Consequently it was decided that a trenching survey using a "backhoe" would presumably be able to reach bedrock and, therefore provide a complete glacial (and geochemical) profile near the deposit.

5.2 Methodology

The Canfield Creek deposit is traversed by a north-south all-weather gravel road called the Crowley Road. A Caterpillar, model 215 BLC, track-mounted excavator was contracted from a local construction firm to excavate a series of trenches along this road. This particular machine is capable of digging trenched up to 4.5 m in depth. By placing the excavator in the roadside ditches ($\leq$1 m deep) a total depth of 5.5 m could be attained.

A lead weight at the end of a "50 foot" tape measure was used to measure the sample depths and also the exact location of any stratigraphic information. Samples were taken at 1-1.5 m intervals in each trench. Prior to sample collection, the operator first cleaned the trench of all glacial material that may have sloughed in from above. The exact depth was then recorded and approximately 25-50 kg of till was excavated and placed away from the excavator for examination. Approximately 3-5 kg of clasts (>1 cm) and about 5 kg of till matrix (<1 cm) were separated from the till sample and placed into plastic bags as the excavator continued to dig. This procedure was continued until the total depth was reached or until bedrock was intersected. The clasts were taken to the laboratory, washed and examined to determine the relative proportion of red versus grey sandstone and also the percentage of non-Carboniferous clasts. Prior to geochemical analysis samples of till matrix were submitted for sample preparation. These procedures are outlined in section 8.

5.3 Results of trenching

A total of 10 trenches were excavated along a 2.2 km section of Crowley Road (Fig. 9). The

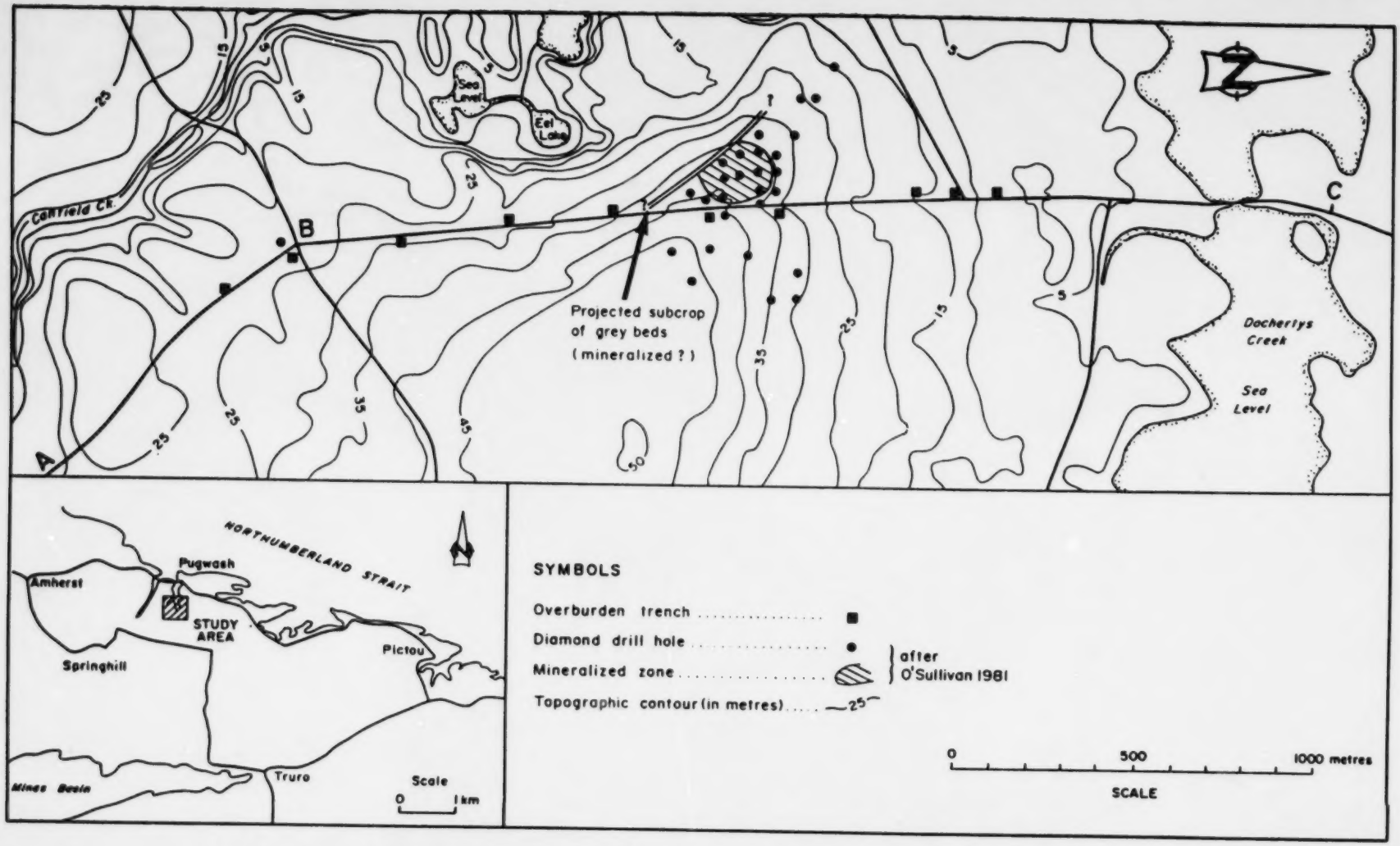

Figure 9. Detailed map of Crowley Road showing the locations of the 10 trenches. Contour lines are for topography, intervals are in metres. The location of the ESSO Minerals Ltd. diamond drill holes, the location of the ore zone and the approximate location of the subcrop of the Canfield Creek ore zone are indicated.

trenches were numbered sequentially in the order that they were dug. The results of trenching are presented in Figure 10. The percentages of various clast-types are given in Table 1. Contoured plots of the relative percentages of grey sandstone and non-Carboniferous clasts are given in Figures 11a and b. It should be noted that the non-Carboniferous clasts are termed "foreign", however there are at least two origins for these well rounded clasts. Firstly they may represent distally-derived rocks that were glacially transported from, for example, the Cobequid Highlands. Conversely, these "foreign" clasts may represent coarse pebbles from local conglomeratic beds within the Carboniferous strata. As such it is not possible to use the relative proportions of these "foreign" clasts as an indicator of glacial provenance in the tills near the study area.

In trenches #1-#5 the till was entirely reddish-brown, moderately compacted silty to sandy Eatonville till. Trench #1 was located approximately 350 m north of the intersection of Crowley and Conns Mills roads. Till clasts were noted to be predominantly reddish-brown ("red") sandstone and mudstone with >80 % in the upper part of the trench. Grey sandstone clasts increased to 30% near the bottom of the trench. In trench #2 (650 m north of road intersection) an outcrop of red sandstone was encountered at 3.0 m depth. As in the first trench the dominant clast type (approximately 75%) is red sandstone/mudstone, however, no increase in grey clasts was noted at the bottom of the trench. Trench #3 was dug above the projected subcrop of the Canfield Creek deposit. The percentage of grey clasts was noted to increase from 4% at 1 m depth to 44% at the bottom of the hole (4.4m). Trench #4 (1250 m north) was dug near the top of the hill, "up-ice" from the Canfield Creek subcrop. As predicted the percentage of grey clasts decreased to 6-21%. Trench #5 (1400 m north) intersected an outcrop of red sandstone at 4.9 m depth. The clasts in this trench were almost entirely red sandstone (91-100%). Trench #6 (1900 m north) was dug at the intersection of Crowley's Road and a secondary road into a small lake to the west. The top 2.5 m of this trench intersected typical reddish-brown Eatonville till with 10-28% grey sandstone clasts. Between 2.5 and 5 m depth, a grey loosely compacted sandy till with >30% grey sandstone clasts was intersected. Approximately 70% of the clasts in these samples were very dark brown with a light greenish hue. These clasts have been tentatively grouped as "red" but may in fact be more appropriately classed as grey. The contact between the two tills was very sharp. This till is interpreted to be the McCarron Brook till as described by Stea and Finck (1988). In an attempt to determine the lateral extent of this lower till, trench #7 was dug approximately 100 m north (2000 m north) of #6. From 0-0.7 m depth, a fine to medium grained red, unstratified, unconsolidated sand was intersected. From 0.7-1.35 m a black organic layer with common branches and tree parts was encountered. From 1.35-1.9 m depth a grey-green coloured, fine- to medium-grained, unconsolidated, unstratified sand was intersected. This sand contained minor twigs and branches. From 1.9-2.5 m depth a second reddish coloured, unconsolidated, largely unstratified sand was encountered. The trench had to be abandoned at 2.5 m because of sloughing problems. It is probable that this sequence of sand and buried peat layers represents a marine to brackish transgression cycle. In a last attempt to further delineate the extent of the McCarron Brook till, trench #8 was dug approximately 100 m south of #6 (1800 m north). A total depth of 4.3 m was reached but the entire section consisted of reddish-brown Eatonville till with only 8-17% grey

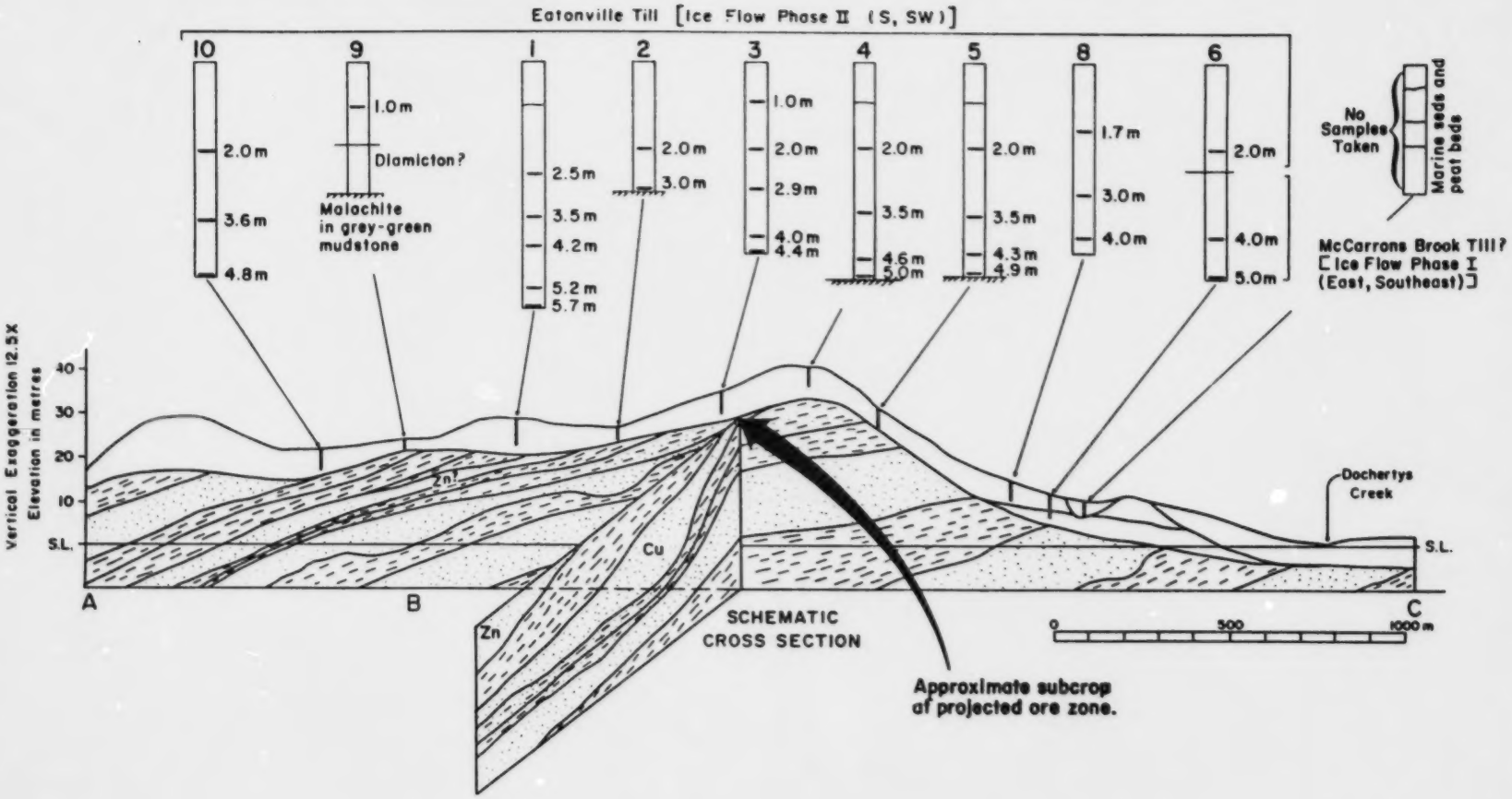

Figure 10. Cross-section along Crowley Road showing the results of trenching. A schematic cross-section of the Pictou Group showing the approximate location of grey and red strata has been included. The approximate location of the subcrop of the ore zone is near trench #4.

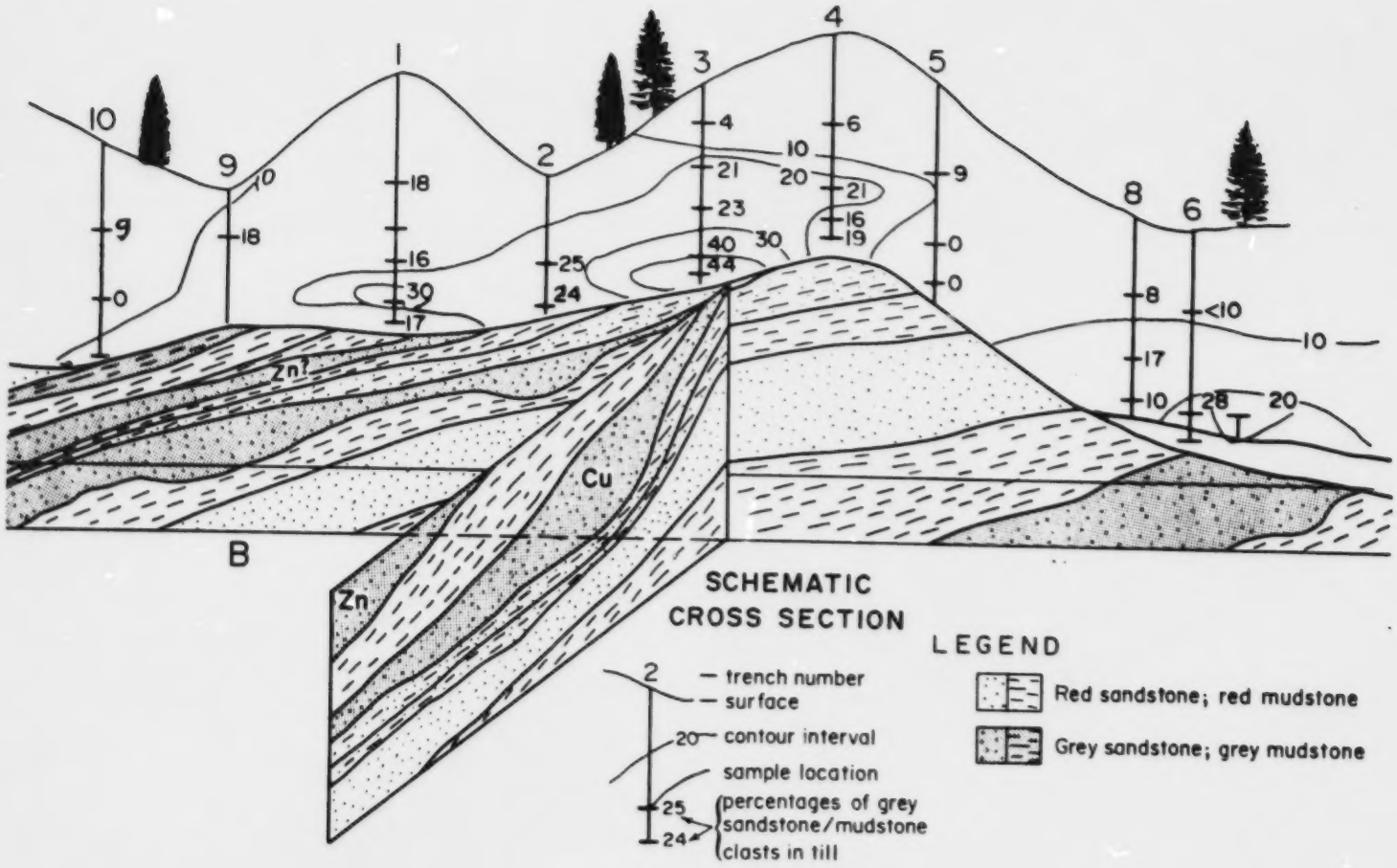

Figure 11a. Schematic cross-section showing the distribution of grey sandstone clasts in till samples collected from the trenches along Crowley Road. Contour intervals are in percent. Note the increase in grey clasts in the lowermost sample from trench #3, immediately "down-ice" from the projected subcrop of the mineralized strata. Increased percentages of grey clasts in trenches #1 and #2 may represent glacial dispersal of the grey strata.

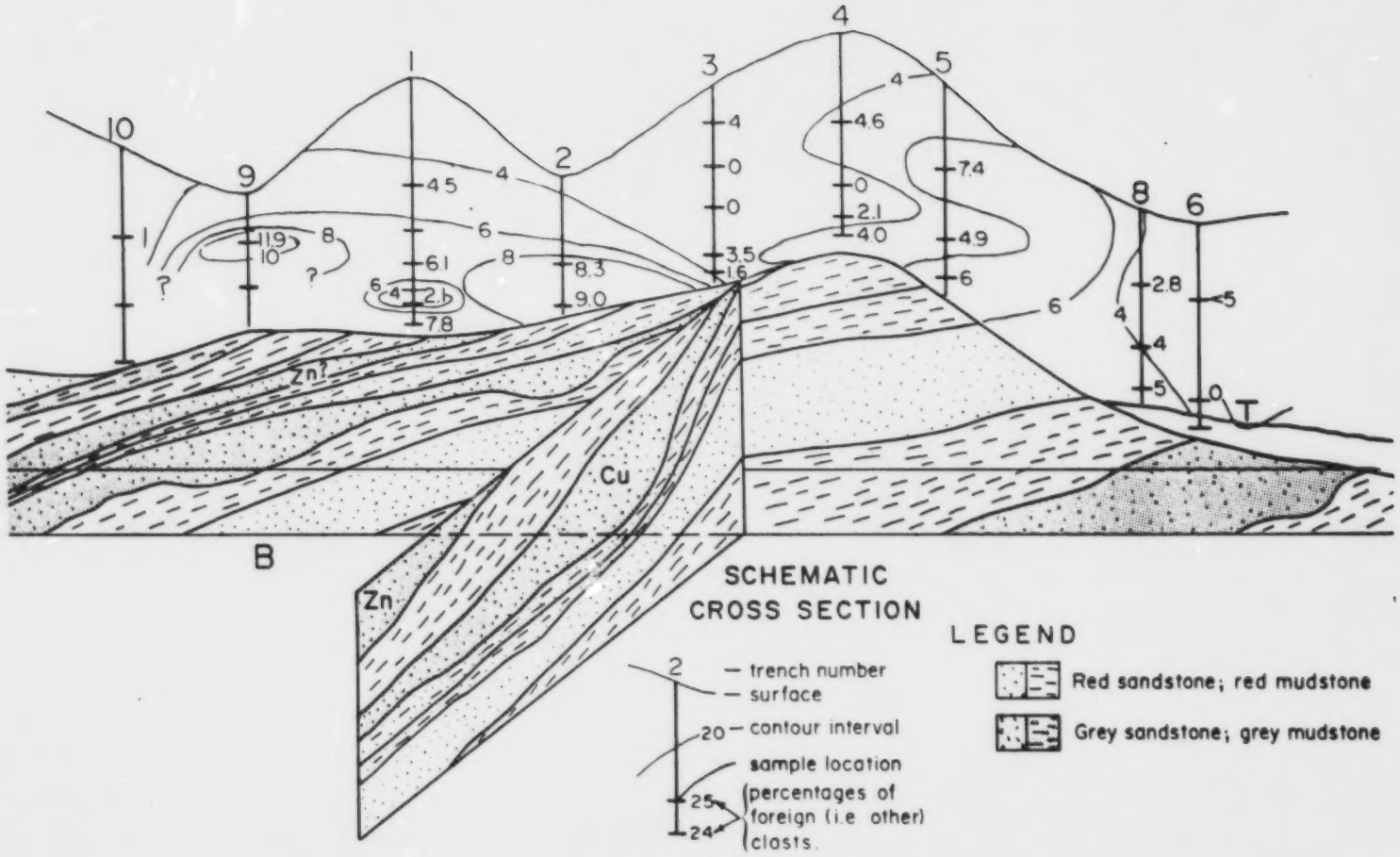

Figure 11b. Schematic cross-section showing the distribution of "foreign" clasts in the trenches along Crowley Road. Contour intervals are in percent. These pebbles may be distally-derived from non-Carboniferous sources (southern New Brunswick) or, more plausibly, may reflect erosion of basal conglomerates within the Malagash Formation.

sandstone clasts. Trench #9 was dug 100 m south of the intersection of Crowley and Conns Mills roads. The upper 1.0 m intersected a typical reddish-brown, clast-poor Eatonville till with minor greenish clasts and reduction spots. At 1.0 m, however, a grey-green mudstone diamicton with common malachite staining along fractures was encountered. At 3.0 m depth a grey-green mudstone outcrop with common malachite staining along fractures was encountered. The diamicton contains numerous angular mudstone fragments in a disagregated mudstone matrix. These features suggest that it may represent glacially modified residual material. Analysis of a suite of samples from 3 samples of the malachite-bearing diamicton and one sample from the underlying bedrock returned 876-2100 ppm Cu, 104-120 ppm Zn, 11-20 ppm Pb, 15-19 ppm Co and <1 ppm Ag. The final trench (#10) was excavated 300 m south of the intersection. The entire trench intersected typical Eatonville till with 90-100% red mudstone and sandstone clasts.

In summary, an investigation of the till clast compositions indicates that there is an increase in grey sandstone/mudstone clasts in the basal part of trench #3, near the projected subcrop of the strata that host the Canfield Creek deposit. Elevated percentages of grey clasts in trenches #1 and #2 presumably reflect down-ice (i.e. south or southwest) dispersal within the Eatonville till sheet. Increased percentages of grey clasts in the lower portion of trench #8 may reflect reworking of till from the underlying, grey sandstone-rich McCarron Brook till sheet. The very low content of grey clasts in trench #10 suggests that there was minimal incorporation of grey/green mudstone from malachite-bearing diamicton and underlying mudstone in trench #9. Conversely, any mudstone that was removed by glaciation may have been quickly comminuted. The presence of a few greenish mud layers in trench #10 might represent comminuted green-grey mudstone from the vicinity of trench #9.

6 REGIONAL SURVEY

6.1 Sampling methodology

The Canfield Creek area posses some interesting and indeed challenging problems for the explorationist. Firstly, many of the "streams" in the area drain into brackish lagoons and are strongly affected by tidal action. These streams are not suitable for sampling because of the uncertainties that are introduced by tidal sedimentation. Secondly, the landforms over evaporite diapirs, such as adjacent to the Canfield deposit, are strongly karstified and often have small bogs or lakes that occupy sinkholes. Many of the sinkholes contain unconsolidated sand deposits of Cretaceous age that in turn may be overlain by Pleistocene sediments, as at the Gays River Pb deposit (Stea pers. comm., 1990). Thirdly, much of the region has been cultivated for most of the past century. Much of the area consists of fields and a great deal of the forested area was previously cultivated fields. As a result, the accumulation of humus is very thin, to non-existent. The possibility of contamination is strong throughout the area. Lastly, it clear from the discussion in section 3 that the Canfield Creek deposit does not have a pronounced geochemical expression compared to, for example, the Yava Pb deposit of southeastern Cape Breton Island (MacDonald et al., 1991).

A regional survey was conducted in conjunction with the trench survey. The objectives of this survey were to: (1) confirm the lack of geochemical response encountered in previous surveys; (2) evaluate the effectiveness of biogeochemical and A-horizon soil sampling techniques over the deposit; (3) provide "background" geochemical data for evaluation of the trench data.

Twenty sampling locations were established along seasonal and all season gravel roads within a 5 km radius of the Canfield Creek deposit. At each site a sample of till, Balsam fir and humus were collected, depending upon media availability. In addition, a sample of Balsam fir and A horizon organic humus was collected at each of the trench location, when available. A total of 19 till samples, 27 humus and 20 Balsam fir samples were collected from the regional and trench sites. The sample numbers and various media collected at each site are indicated in Figure 12. Till samples were available at all sites except CC-90-03 which was underlain by a reddish-brown varved clay (glacial lake?). Humus was available at all sites except 4 of the trenches where recent agricultural activity has disturbed the soil profile. Balsam fir was available throughout the area except in several sites along the Conn's Mills-Pugwash Junction Road and at the trench sites that were excavated along hay fields.

6.2 Till clast distribution

The till clasts (>1 cm) were washed and subdivided into three main lithological categories including: (1) reddish-brown sediments (mostly sandstone and mudstone) hence termed red; (2) grey or greenish-grey sediments (mostly sandstone and mudstone); and (3) non-Carboniferous or "foreign" clasts including granitoids, mafic and felsic volcanics,

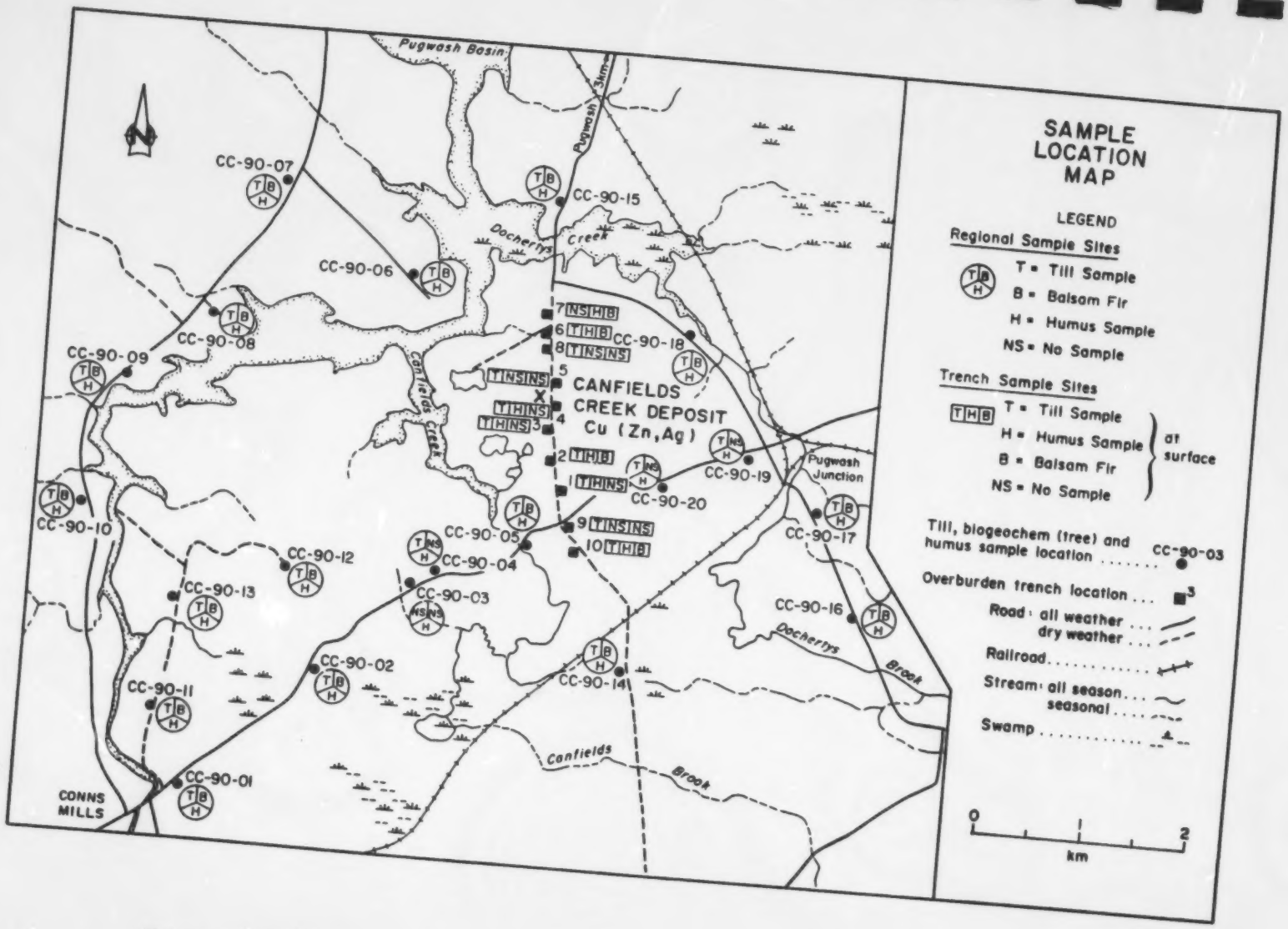

Figure 12. Sample location map for the regional and trench surveys showing the distribution of till, Balsam fir and humus samples.

metasediments and quartz pebbles. The relative percentages of the three clast categories are plotted in Figure 13. Contours denote the percentages of red sandstone/mudstone.

With the exception of sample CC-90-04 which only has 73% red sediments, the samples from the central portion of the study area have a very high percentage of red clasts (>90-100%). In contrast, the outlying areas of the study area have significantly lower percentages of red clasts (50-90%). Ryan (1986) describes the geology of the Tatamagouche Syncline area, in particular he discusses the proportions of red versus grey strata in the various formations. The present topography in the study area is presumably at, or near, the shallow-dipping contact between the overlying Balfron Formation which has approximately 75% red strata, and the underlying Malagash Formation with approximately 60% red strata in the upper parts. Interestingly the highest percentages of red clasts in till correspond approximately with the proposed outline of the Windsor Group evaporite dome. This correlation may be fortuitous but more likely there is some causative relationship, possibly related to folding near the diapir.

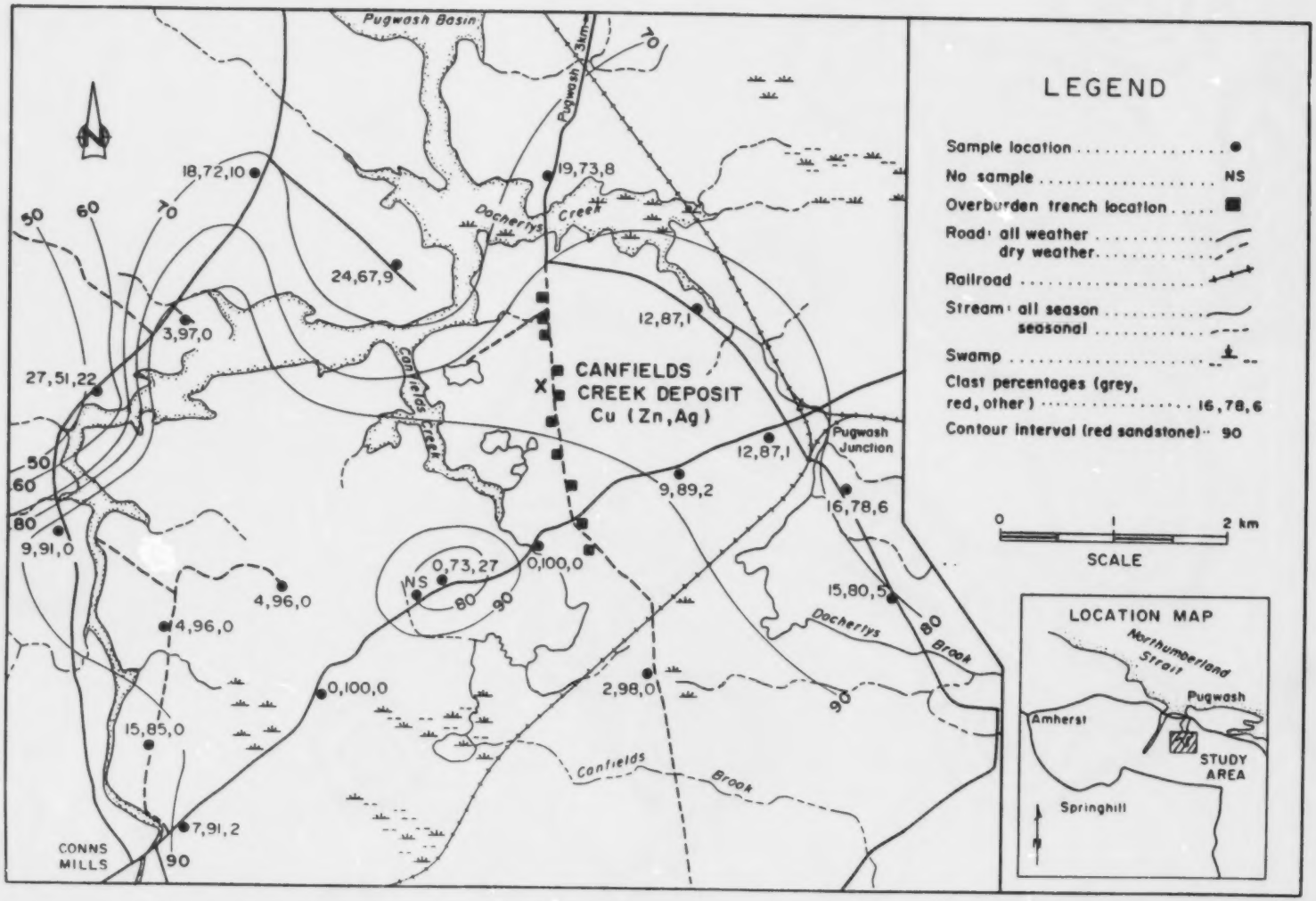

Figure 13. Distribution of till clast types in the till samples from the Canfield Creek area. Contours correspond to the percentages of red sandstone clasts (see text for discussion).

7 SAMPLE PREPARATION

All sample preparation procedures for this survey were conducted at the Minerals Engineering Centre at TUNS in Halifax, Nova Scotia. The following sections outline the specific techniques that were employed.

7.1 Till matrix

Till matrix and stream sediment samples received the same sample preparation procedures. A flow chart of these procedures is given in Figure 14. The first step was to wet sieve the samples into -230 (-62.5μm), -60+230 (-250+62.5 μm) and +60 (+250 μm) mesh size fractions which were subsequently dried in an oven at 110°C for 12 hours. Each fraction was then weighed. The +60 (+250 μm) mesh fractions were placed in plastic bags and placed in archival storage. Subsamples of the -230 (-62.5μm) fractions were placed into 30 ml plastic vials and submitted for major and trace element analysis by ICP-AES (see below). The excess material was placed in 500 ml wide-mouth jars and placed in storage.

Approximately 500 gms from the -60+230 (-250+62.5 μm) mesh fractions were used for heavy liquid separation with tetrabromoethane (2.95 S.G.). The "light minerals" (<2.95 S.G.) were placed in plastic bags and archived. The "heavy minerals" (>2.95 S.G.) were ultrasonically cleaned in acetone and air-dried. They were then separated into magnetic and non-magnetic fractions using a specially-designed, hand-held magnet. The magnetic fraction, which mostly contains magnetite with subordinate ilmenite and pyrrhotite, was placed in 30 ml vials and archived. This procedure reduces the amount of Fe in the heavy mineral concentrate which may cause interferences in some analytical techniques, particularly in Instrumental Neutron Activation Analysis (INAA). Approximately 0.1 gm of the non-magnetic fraction was placed in small glass vials and will be used for future mineral identification studies. The remainder of the non-magnetic fraction was sent to Chemex Laboratories in North Vancouver, British Colombia where they were crushed in a pan con ring to approximately 150 mesh prior to analysis for major and trace elements (see below).

7.2 Balsam fir

A flow chart for the sample preparation procedures used for Balsam fir is given in Figure 15. The Balsam fir branches were air dried in their kraft bags to remove most of their moisture. The needles which characteristically contain relatively low concentrations of most trace elements were then stripped from the branches by hand and stored in plastic bags for possible future use. The branches were then placed in ceramic trays and heated for 4 hours at 500°C in a furnace. Several samples still contained minor amounts of charcoal-like material following heating so they had to be re-ashed. It is suggested that the ashing technique of Dunn et al. (1989) be employed in future biogeochemical surveys. The decision to ash the samples was based upon the premise that ashing will give the highest values possible because of the pre-concentration and therefore may give good analytical results for elements that might be nearing detection limits in non-ashed humus samples.

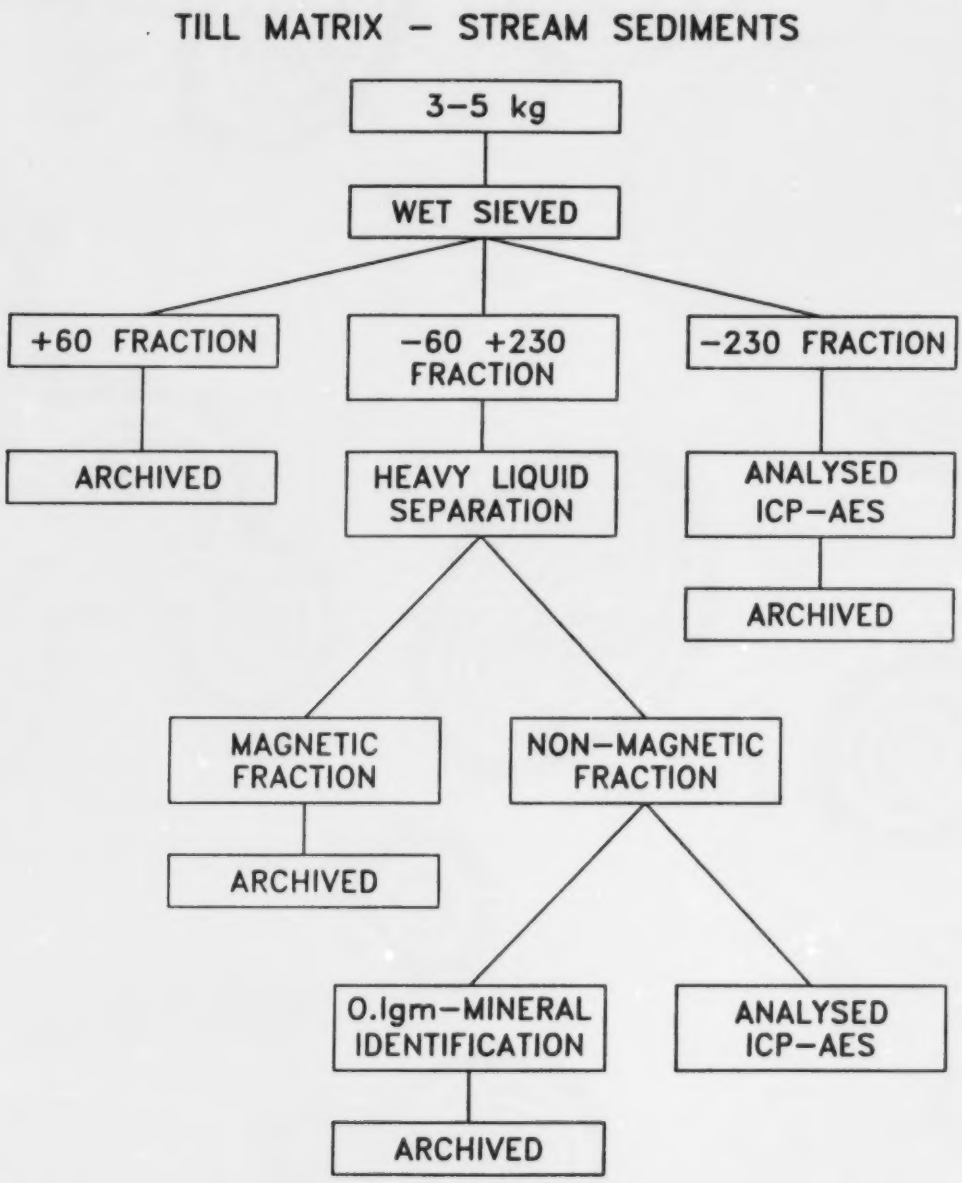

Figure 14. Flow chart outlining the sample preparation procedures for till matrix.

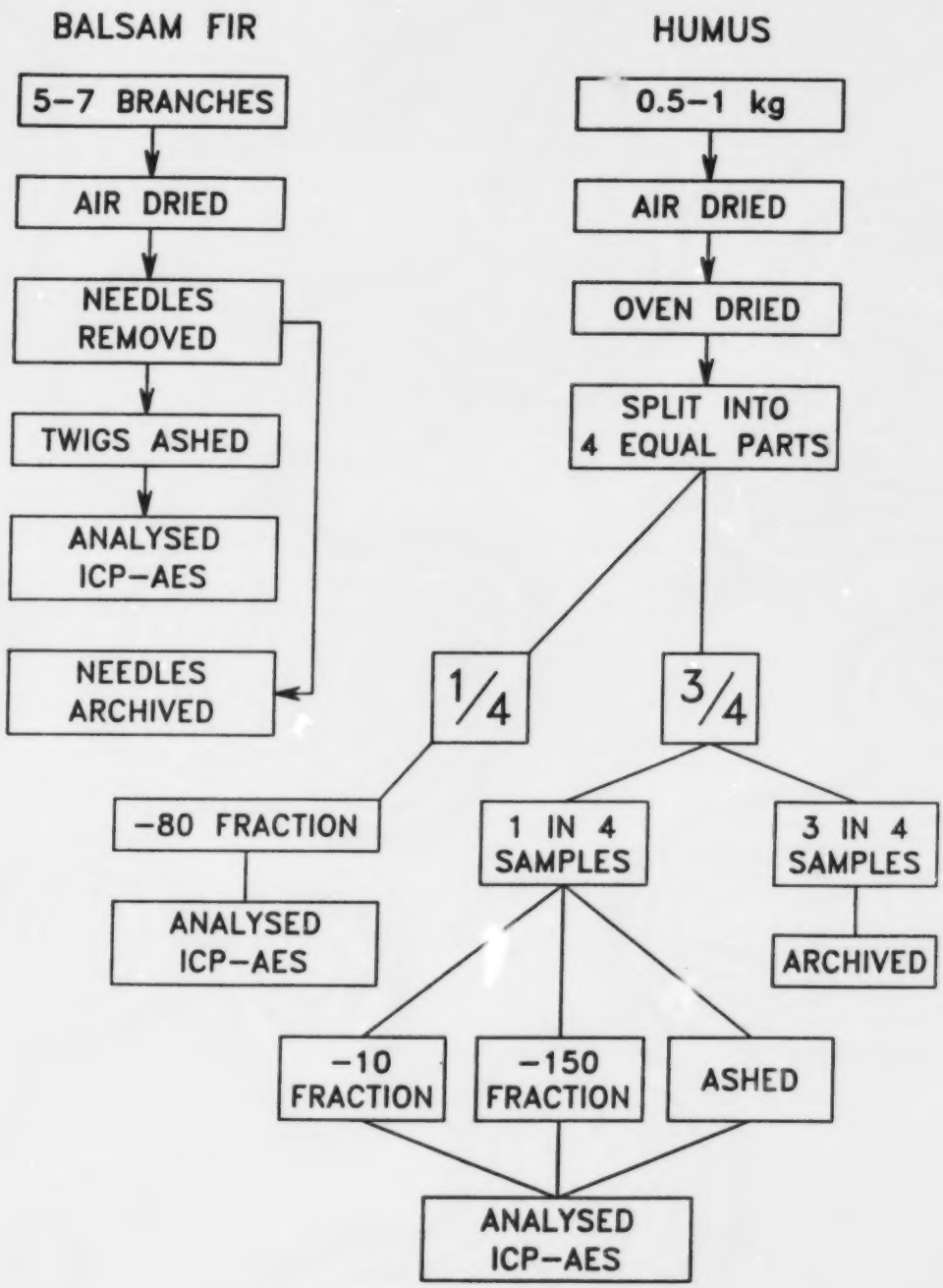

Figure 15. Flow chart outlining the sample preparation procedures for the Balsam Fir and humus samples.

7.3 Humus

A flow chart for the sample preparation procedures used for humus is given in Figure 15. The humus samples were first air-dried in their kraft-paper bags and subsequently placed in a furnace at 110°C overnight to remove all moisture. Each sample was then homogenized and divided into four equal portions using a riffle splitter. One portion from every sample was then dry-sieved to -80 (-177 μm) mesh to remove large non-decomposed organic material and any coarse clastic grains. This fraction was then submitted for major and trace element analysis (see below). Two of the remaining portions from every fourth sample were dry-sieved to -10 (-2000 μm) and -150 (-100 μm) mesh. The final portion from every fourth sample was placed in a ceramic tray and ashed in a furnace at 500°C until all of the glowing embers and black charcoal was eliminated. This mostly required at least 4 hours of heating. All sieved and ashed samples were placed in 30 ml plastic vials and have been submitted for analysis by the same technique as the -80 (-177 μm) mesh fraction. However, the analytical results were not available at the time of this report and will be described in upcoming reports. The purpose of analysing subsamples produced by different preparation techniques is to establish the optimal sample preparation technique for future programmes.

8 ANALYTICAL PROCEDURES AND RESULTS

The following section outlines the various analytical procedures and resulting data for all of the sample media. The data and quality control information is presented in a series of tables in Appendix A at the back of the report.

It was decided that a preliminary evaluation of the data be undertaken. Perhaps the most challenging problem in exploration geochemistry is the statistical analysis, evaluation and display of the data. Ultimately the goal of this procedure is to measure the relationship between the distribution of data and the presence (or absence) of underlying geological features, such as varying till or bedrock types, mineralization or structures.

Previous reconnaissance and detailed geochemical surveys in Nova Scotia have used various methods for data manipulation. For example Rogers and MacDonald (1984), assigned "threshold" values according to the method of Hawkes and Webb (1962). Threshold was calculated as mean + 2 x Std. Dev. In a normally distributed data set this T would correspond to the 97.5th percentile of the data. Other workers, for example Turner and Stea (1987), used the 95th percentile of their data set to represent an "anomaly level". They then portrayed their data using "star" symbols that corresponded to multiples of these anomaly levels. Some workers have generated trend surface plots for till (Boner et al., 1990) and lake (Rogers et al., 1990; Lombard, 1991) surveys where intervals correspond to various percentile values, for example 75th, 90th, 95th and 99th percentiles. The major problem with these techniques is that the actual distribution of the data is overlooked. For example a group of "anomalous" data from a potentially mineralized region may constitute a large proportion of the data set, say 30%. If only values in excess of the 95th percentile are considered "anomalous" a large portion of this information may be disregarded. Garret (1991) and Sinclair (1991) succinctly summarized this problem and suggests that the proper procedure for allocation of "inspection levels" should involve the distribution of data within the specific survey. For a complete discussion of this issue the reader is referred to these publications and references contained within. They suggest that this can be accomplished by using cumulative frequency or cumulative probability plots to establish "breaks" in the data.

For the purpose of this report we have generated a series of cumulative probability plots for the till, humus and Balsam fir data sets. It must be stressed that the interpretations of the data in this report are preliminary and are intended to point out the major geochemical characteristics of the sampled media near the deposit. In future, more rigorous statistical treatment of the data may indicate more subtle trends or data characteristics. These statistical techniques include the use of non-parametric geostatistical (e.g Kriging) and various parametric statistical procedures (e.g. mean, inter-quartile range, cumulative frequency) to establish inspection levels and/or aid in the interpretation of the data.

8.1 Till matrix

8.1.1 -230 (-62.5μm) fraction

Samples of the -230 (-62.5μm) mesh fraction from till samples collected during the regional and trench surveys were submitted to Bondar Clegg Co. Ltd. in Ottawa Ontario for analysis.

Approximately 0.5 gm was digested in a 1:3 ($HCL-HNO_3$) LeFort Aqua Regia solution. The resulting solutions were analysed by the Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) technique for a suite of 38 elements.

Analytical results for the 19 regional and 31 trench till samples are given in Table 2a of Appendix A. Data is presented for 17 trace elements (Li, Sc, V, Cr, Co, Ni, Cu, Pb, Zn, As, Sr, Y, Zr, Ag, Ba, La and Ta) and 6 major elements (Al, Fe, Mn, Mg, Ca and K). Analytical results for standards, analytical sample splits and field duplicates are given in Tables 2b to 2d of Appendix A. Many of the 38 analysed elements were noted to be mostly, or entirely, below detection limits and have been eliminated from Table 2a. These include Be, Ga, Rb, Nb, Mo, Cd, Sn, Sb, Te, Ce, W, Bi, Ti, Na and P.

Lithogeochemical analysis of diamond drill core from the Canfield Creek deposit (unpubl. data R.J. Ryan) indicates that the mineralized zone is composed primarily of Cu-ore. In fact, concentrations of Zn, Pb, Ag, Co and other trace elements that are recurrently enriched in sediment-hosted mineral deposits are not elevated in the Canfield ore compared to "background" levels in unmineralized Cumberland Basin strata. Accordingly, the following discussions of the geochemical response the Canfield deposit, or lack of, will focus on Cu with mention of Zn, Pb and Ag.

A plot of the Cu, Pb, Zn and Ag concentrations in the samples from the 9 trenches and 19 detailed survey are given in Figures 16 and 17 respectively. Note the raw data is presented in the Figures whereas the field and analytical duplicates have been averaged for presentation in Table 2a. The distribution of Cu in the regional samples is fairly uniform ranging from 6-17 ppm (av. 10.4, Std. Dev. 2.7 ppm). Much of the trench data is comparable to the regional data indicating minimal enrichment in Cu associated with the deposit. An investigation of the cumulative probability plot for Cu for all till samples, including field duplicates, indicates a single population with three outlying samples (above upper arrow in Fig. 18a) that exceed 25 ppm. All three samples were collected in trench #6 from the grey sandstone-dominated McCarron Brook till unit. Two samples were collected at 5.0 m depth whereas the third is an analytical split of the sample from 4.0 m depth. There is a very slight inflection in the cumulative frequency curve at 15 ppm (second arrow in Fig. 18a). Six samples have concentrations between 15 and 25 ppm. These are from the bottom of trench 2, the upper portion of trenches #1 and #10 and from the sample taken south of the trench survey along Crowley Road. In spite of the subtle separation from the majority of the data, the location of these samples of Eatonville till over and "down-ice" from the deposit suggests that a threshold of 15 ppm Cu may be useful for locating "subtle positive anomalies". It should be stressed that the lack of either a pronounced lower "tail" of data or a distinct lower data population near the deposit suggests that there are no pronounced "negative Cu anomalies" within the -230 mesh fraction from the till samples.

The cumulative probability plot showing the distribution of Pb for all till samples is presented in Figure 18b. The majority of the data defines a single population that ranges in concentration from 6 to 24 ppm, however, there is a second population, that ranges in concentration from 37 to 64 ppm. All five samples from this population were collected from the McCarron Brook till unit at the bottom of trench #6. There is no apparent correlation between Pb concentration, for the remainder of the data, and proximity to the deposit. Thus

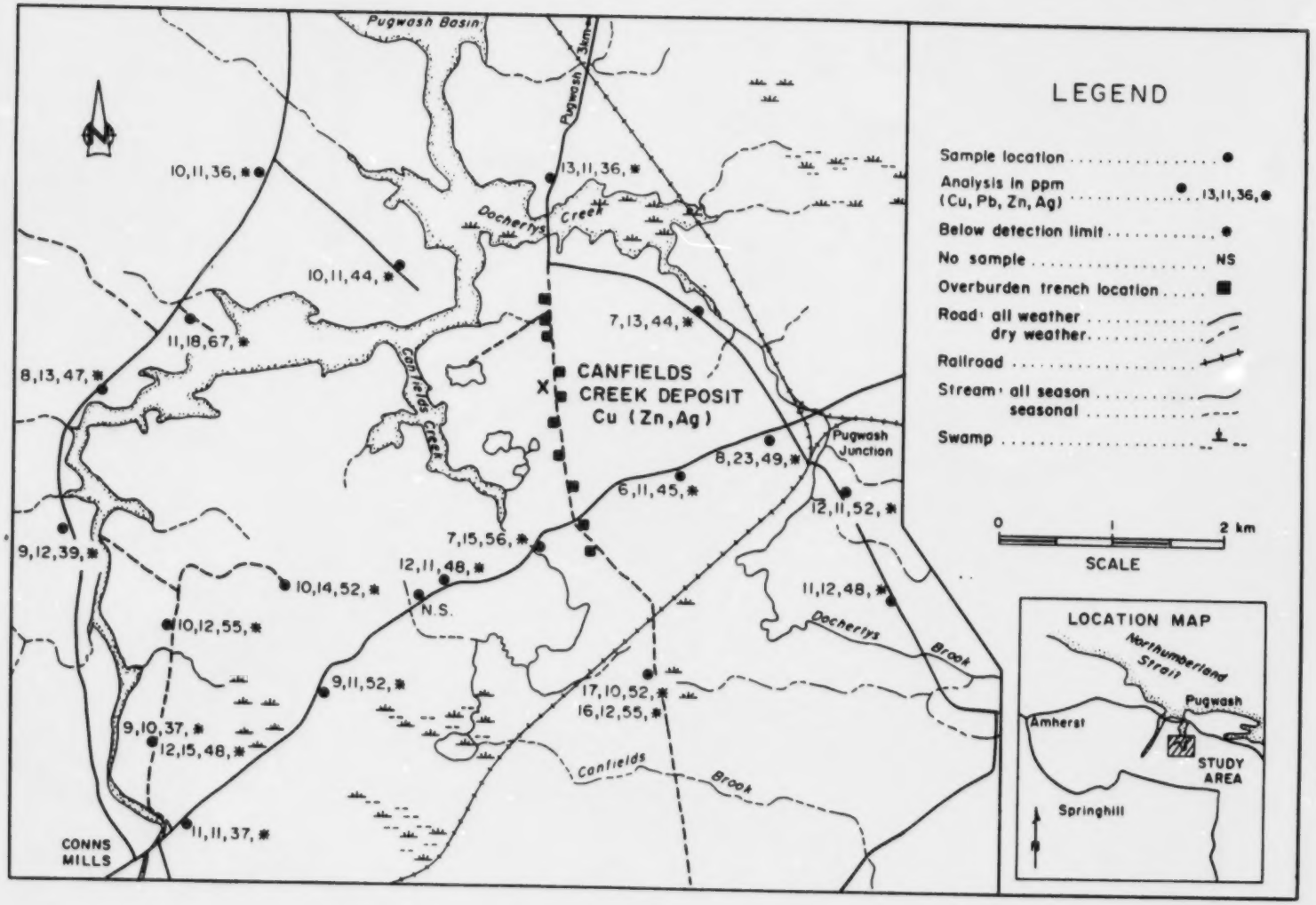

Figure 16. Plot of Cu, Pb, Zn and Ag data for the -230 mesh fraction of regional till samples from the Canfield Creek survey.

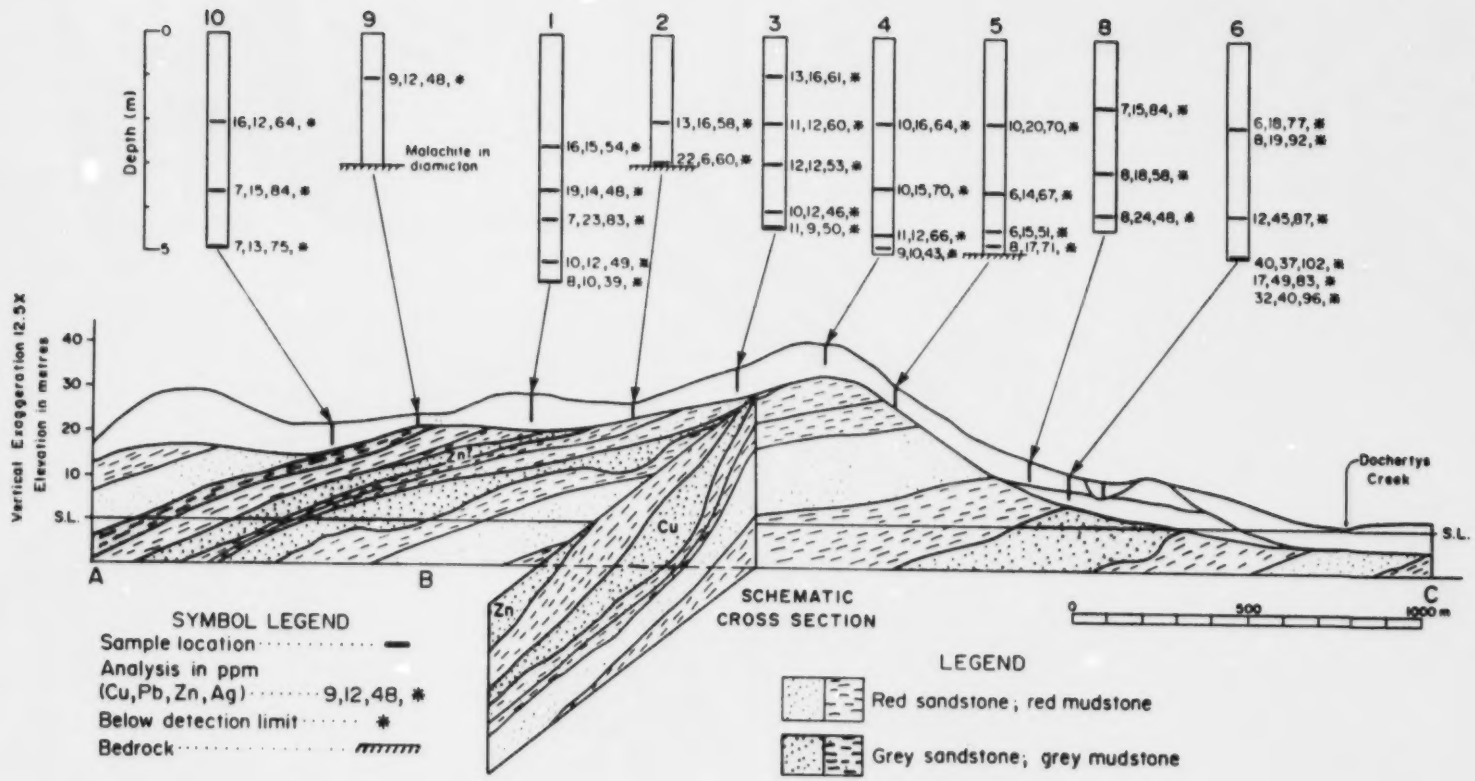

Figure 17. Plot of Cu, Pb, Zn and Ag data for the -230 mesh fraction of till samples from the Canfield Creek trench survey.

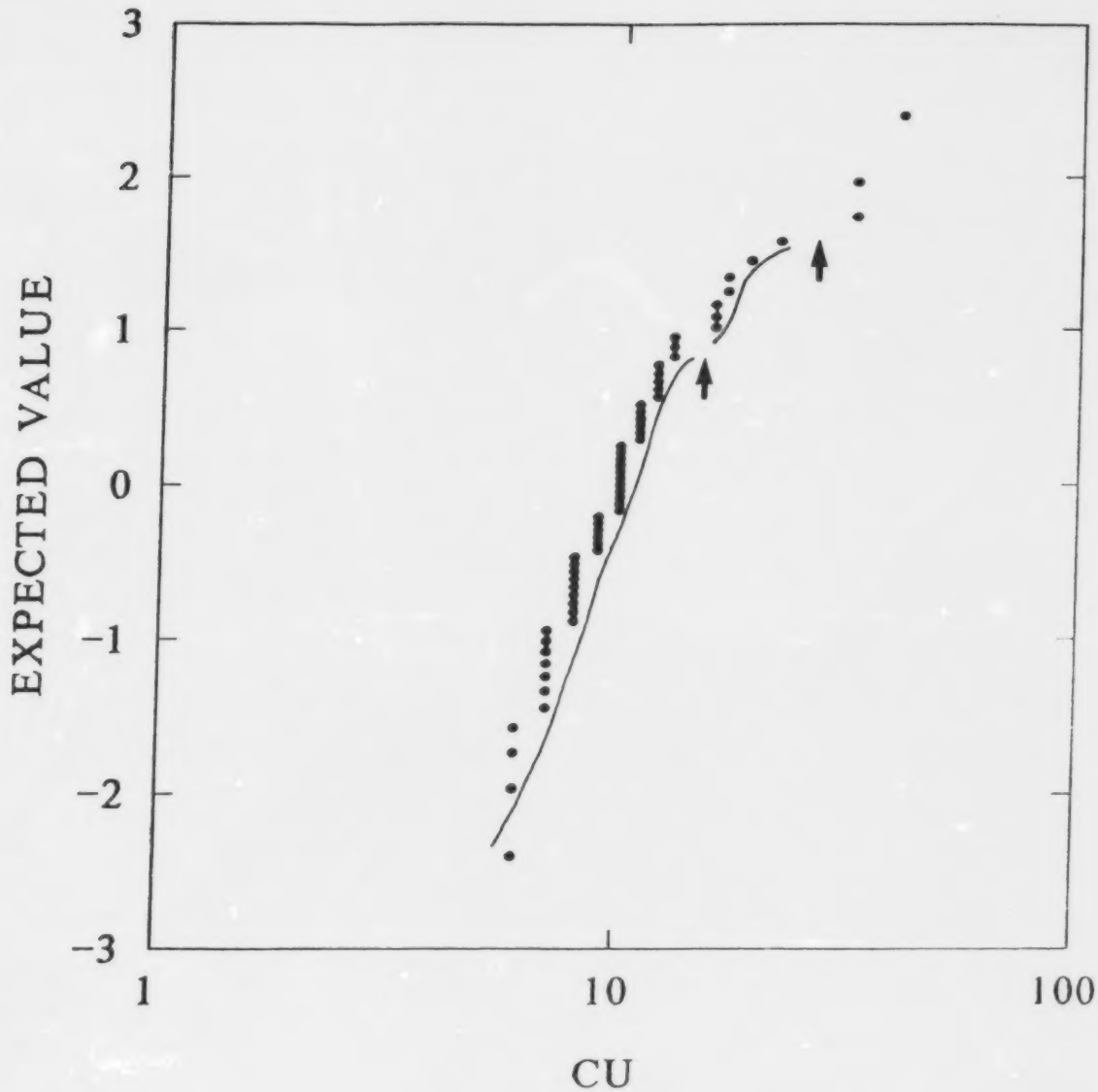

Figure 18a. Cummulative probability plots for Cu from the -230 mesh fraction of till samples from the regional and trench surveys.

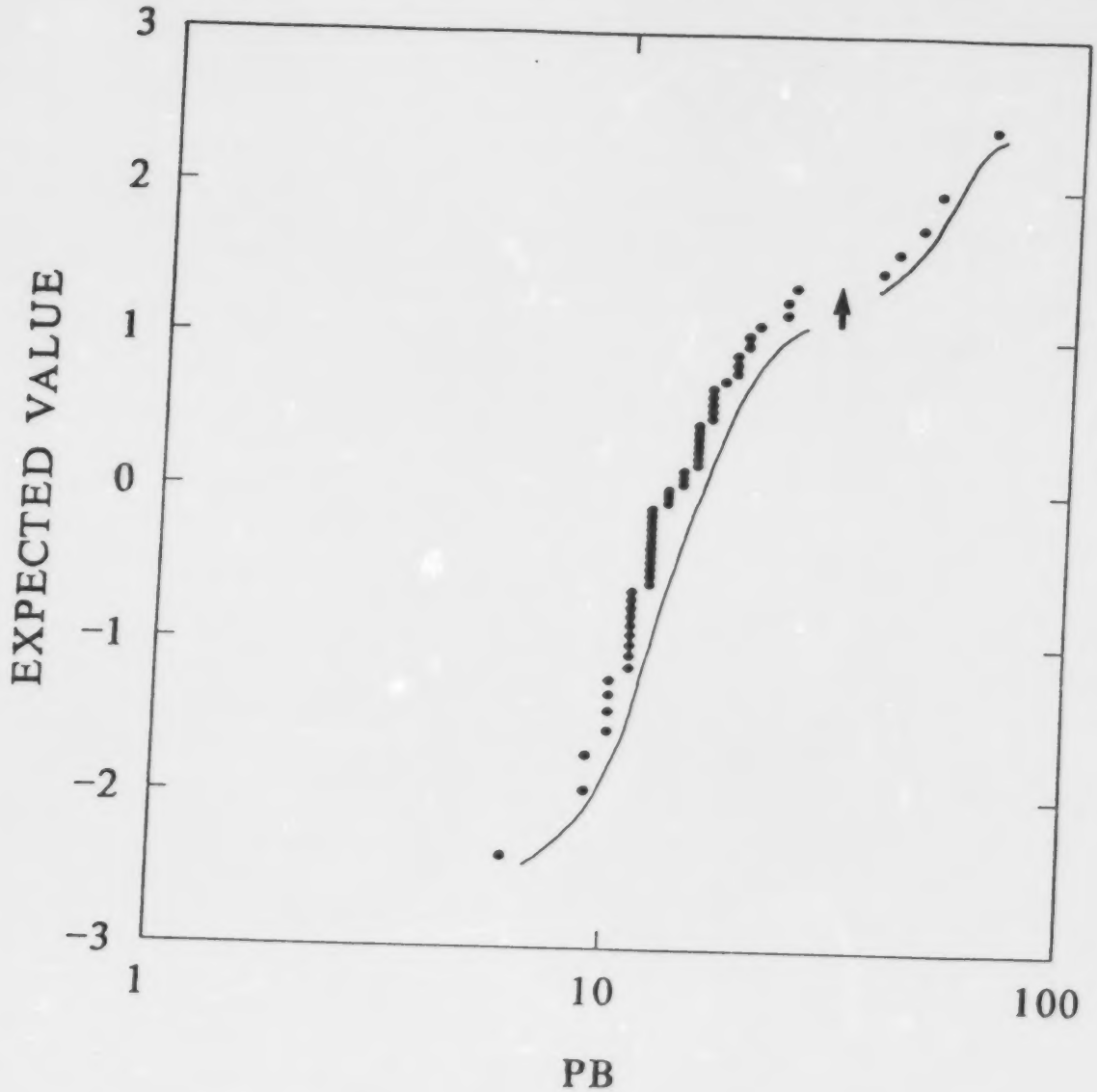

Figure 18b. Cummulative probability plots for Pb from the -230 mesh fraction of till samples from the regional and trench surveys.

no consistent positive or negative Pb anomalies, in the -230 mesh fraction of till, are associated with the Canfield deposit.

The cumulative probability plot showing the distribution of Zn in all till samples is presented in Figure 18c. There is a small break in the Zn plot at 80 ppm (denoted by arrow). The samples that exceed 80 ppm Zn are mostly from the trenches. Once again 4 samples from the McCarron Brook till in trench #6 were some of the highest values with a few samples from trenches #1, #8 and #10 also plotting in this upper "population". There is no apparent correlation between proximity to the subcrop of the ore-bearing horizon(s) and Zn values in the Eatonville till. All of the -230 mesh fractions of the till samples had concentrations of Ag below 0.2 ppm (Fig. 18d).

There is some enrichment in Al, Fe, Mg, Ca and K in the trench versus regional samples. Similarly, there is minor enrichment in some trace elements in the trench samples compared to the regional samples. These enrichments are not considered to be related to mineralizing processes, particularly in light of the above lithogeochemical data, but may reflect elemental decreases in the "regional" samples from weathering processes.

In summary, there is a slight enrichment (>15 ppm) in Cu in the -230 (-62.5 μm) mesh fraction from till samples near and "down-ice" from the projected subcrop of the Canfield Creek deposit. There is no apparent enrichment, or depletion, in Pb, Zn or Ag near the deposit.

8.1.2 Heavy minerals from -60+230 (-250+62.5 μm) fraction

The non-magnetic portion of the -60+230 (-250+62.5 μm) mesh heavy mineral separates from the grid samples were sent to Chemex Laboratories Ltd. of North Vancouver, British Columbia for analysis. Approximately 0.5 gm of sample were digested in a mixture of nitric-perchloric-hydrofluoric-hydrochloric acids and analysed for a suite of 25 major and trace elements (Ag, Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sr, Ti, V, W, Zn and Zr) by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES). The standard upper limit for most trace elements by this technique is 10 000 ppm. All samples that contained trace element concentrations in excess of this upper limit were subsequently re-diluted and reanalysed to obtain precise concentrations.

The Canfield Creek ore zones occur in porous channel sandstones that typically, as noted in the Yava deposit (Sangster and Vaillancourt, 1990), contain higher modal amounts of heavy minerals than do the unmineralized sandstones. This may be reflected in tills derived from the deposit. Zircon (Zr) and rutile (Ti,Fe) are mostly insoluble in the above multi-acid digestion and therefore concentrations of Zr and Ti should be anomalously low by this technique. Conversely, barite is very soluble in the multi-acid digestion but tends to complex with Cl (from dissociated HCl) to form BaCl which is very insoluble and will precipitate from solution prior to analysis. Therefore, Ba values may also be anomalously low when the standard multi-acid digestion is employed. To counter these effects, approximately 0.2 gm of the heavy mineral concentrates were mixed with a lithium-metaborate flux and fused in platinum crucibles over a bunsen burner. The resulting glass beads were then digested in nitric acid and analysed by the same ICP-AES procedure. As predicted, there were

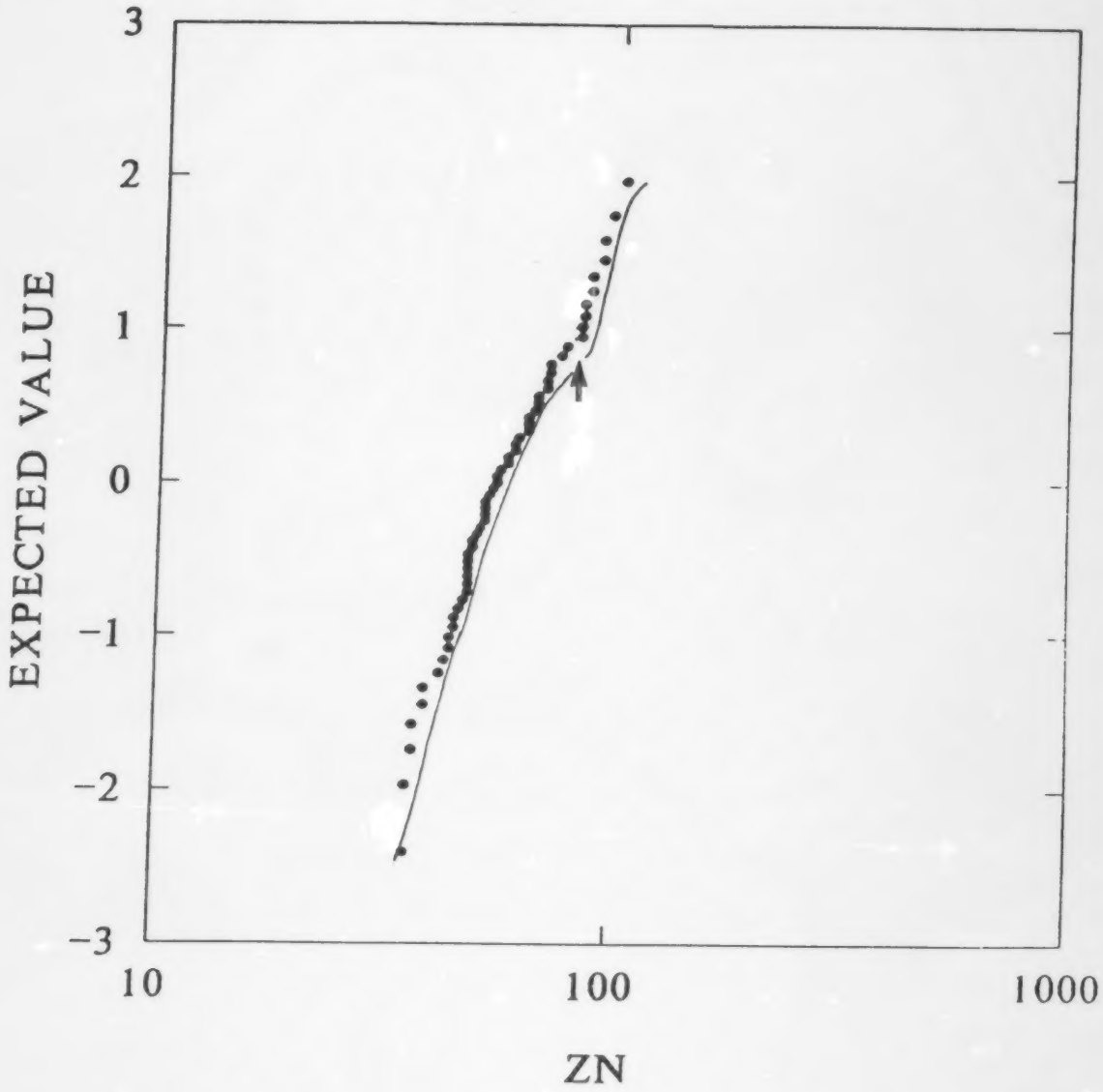

Figure 18c. Cummulative probability plots for Zn from the -230 mesh fraction of till samples from the regional and trench surveys.

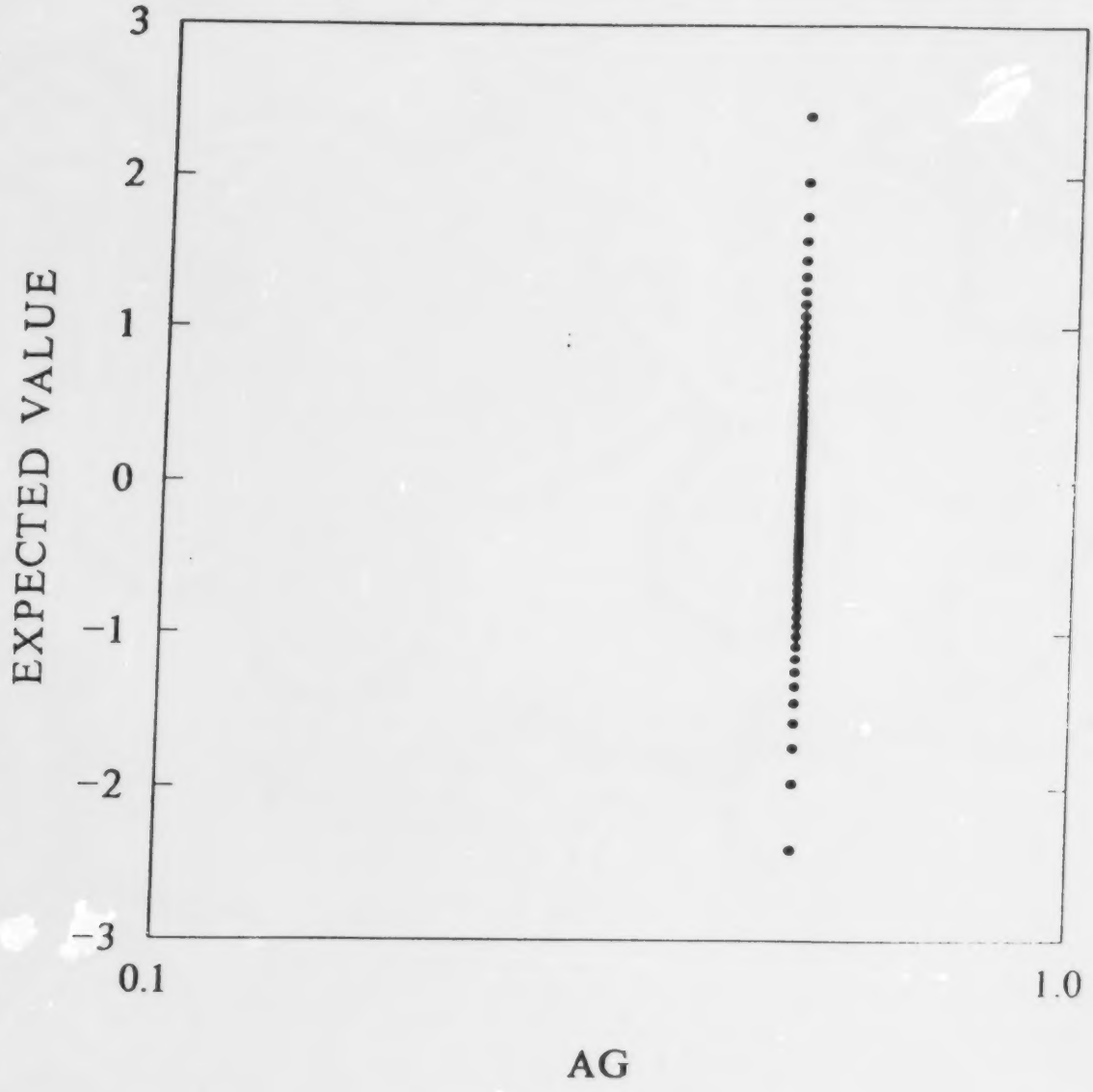

Figure 18d. Cummulative probability plots for Ag from the -230 mesh fraction of till samples from the regional and trench surveys.

substantial increases in Ba,Zr and Ti and minor increases in several major elements. Therefore the analyses from the Li-metaborate fusion have been substituted for the initial Al, Ba, Ca, Fe, Mg, Mn, Na, Ti and Zr values whereas the remainder of the elements were determined by the above multi-acid digestion. For a complete discussion of the analytical results for both sample preparation techniques the reader is referred to MacDonald et al. (1991). Analytical results (unweighted) are given in Table 3a of Appendix A. Several samples did not have sufficient sample for the Li-metaborate fusion. These samples will have i.s. (insufficient sample) for the appropriate elements in Table 3a. Virtually all samples had concentrations of Be,Bi and W that were below detection limits (0.5,2 and 10 ppm respectively) and accordingly these elements have been omitted from Table 3a.

The raw analytical data was weighted according to the method of Toverud (1982) using the formula El(W)= El(R) x (W1/W2), where El(W) is the weighted element value, El(R) is the raw analytical value for that element, W1 is the heavy mineral concentrate extracted from a measured weight (W2) of the -60+230 (-250+62.5 μm) mesh till matrix. The weighted values are given in Table 3b of Appendix A. Unweighted and weighted data for the standards, analytical sample splits and field duplicates are given in Tables 3c to 3g of Appendix A.

A plot of unweighted and weighted Cu, Pb, Zn and Ag concentrations for the regional and trench surveys are given in Figures 19a,b and 20a,b respectively. All of the heavy mineral concentrates from both regional and trench samples had concentrations of Cu that were below 1 ppm (i.e. detection limit; reported as 0.5 ppm) with the exception of: 1) a trench sample taken at a depth of 5.0 m from trench #6 with 381 ppm (av. of 3 samples; weighted value - 1.84). This sample was taken from the grey sandstone-dominated McCarron Brook till unit; 2) a sample from 4 m depth in trench #4, over the deposit with 9 ppm Cu weighted value - 0.05); and 3) sample CC-90-14 located approximately 2.5 km south of the Canfield deposit with 23 ppm Cu (weighted value - 0.22). A cumulative probability plot for weighted Cu is given in Figure 21a. The "normally distributed" curve below 0.02 ppm (weighted) is purely a function of the weighting process. That is, all of these samples had concentrations below detection limits but had varying weights of heavy mineral separates. In light of this caution should be exercised when interpreting the other cumulative probability plots for Pb, Zn and Ag (Figs. 21b to 21d).

A cumulative probability plot for Pb is given in Figure 21b. Several observations can be made, including: 1) there is a "break" in the data at approximately 2.0 ppm (noted by upper arrow). Samples collected above this break were collected from the bottom of trench #4 (2 samples), from the bottom of trench #10 and from the McCarron Brook till unit at the bottom of trench #6; 2) a subtle "break" in the data occurs at 1.5 ppm (lower arrow). The samples between these two points were collected from sites CC-90-2, -10 and -11 near Conns Mills, from trench #3 (@ 1.0 and 4.0 m depth) and one sample each from trenches #4, #8 and #9; and 3) a slight "break" in the data is evident at approximately 0.5 ppm that implies a lower "population" that includes samples CC-90-4 and -17 and samples from trenches #5 and #6. In general the Pb data for the heavy mineral concentrates does not correspond to the Canfield occurrence and shows "spotty" distribution throughout the study area.

A cumulative probability plot for Zn is presented in Figure 21c. It is evident from this plot

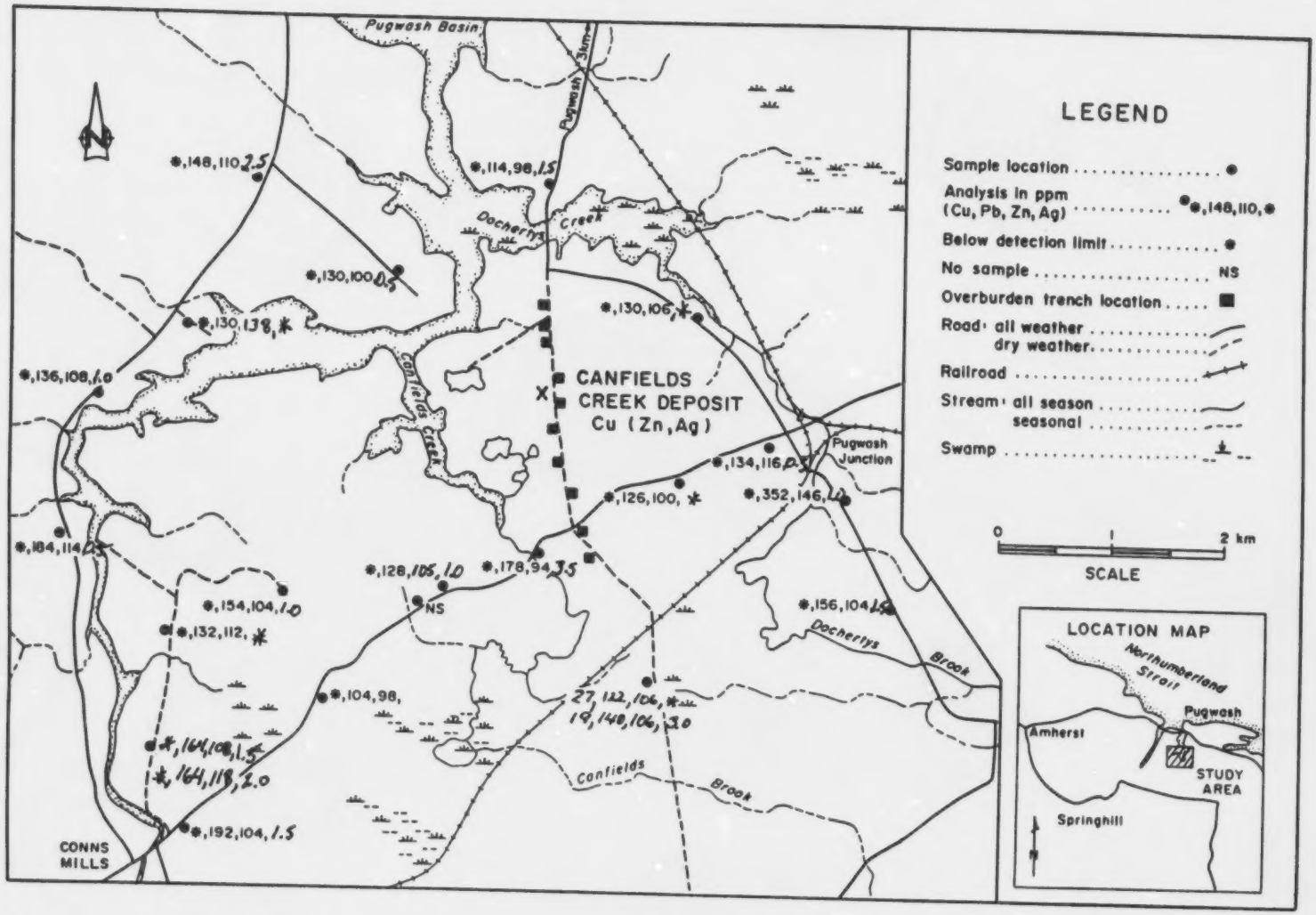

Figure 19a. Plot of unweighted Cu, Pb, Zn and Ag data for the non-magnetic heavy mineral separates from the -60+230 mesh fraction of regional till samples from the Canfield Creek survey.

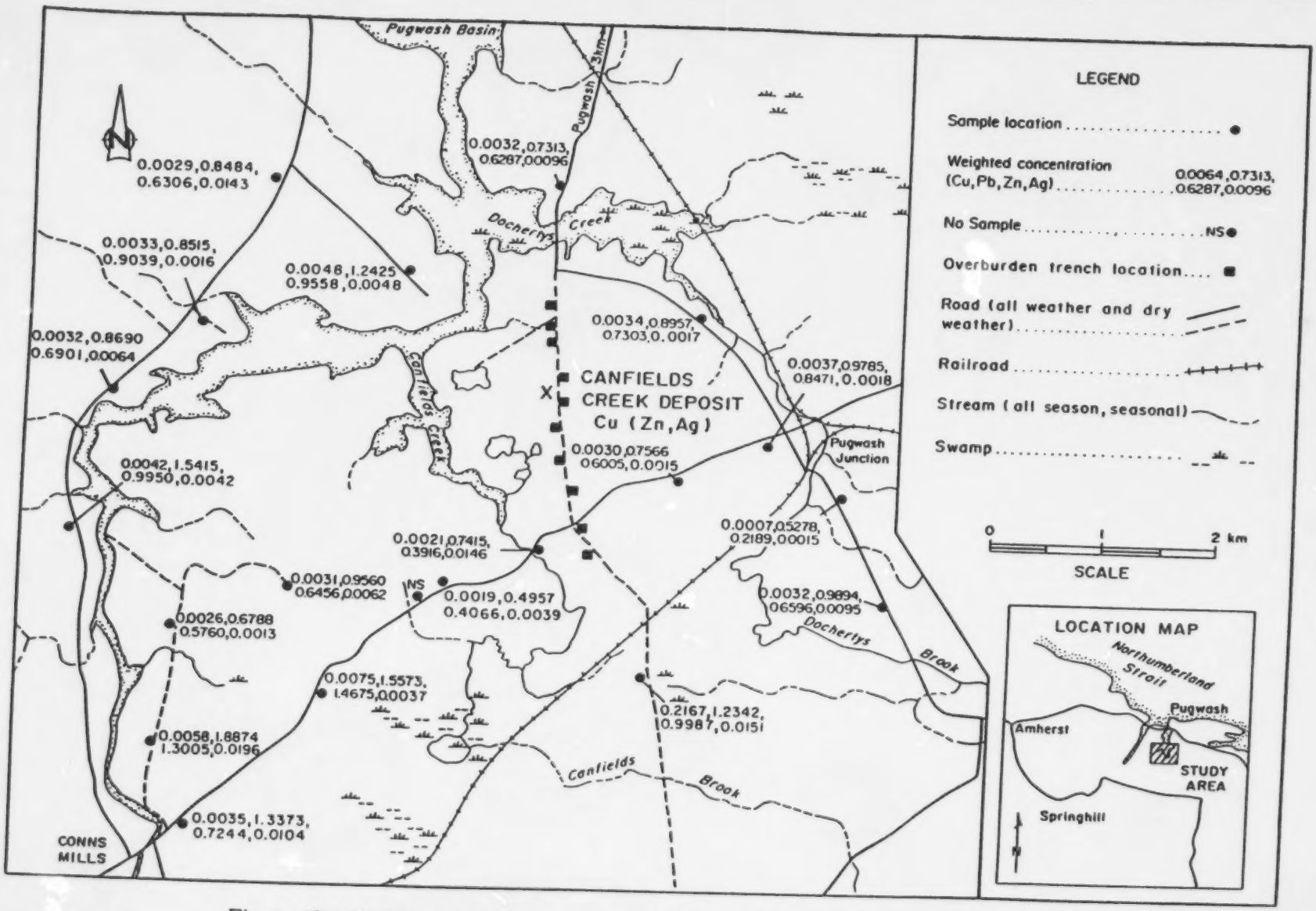

Figure 19b. Plot of weighted data (Cu, Pb, Zn and Ag) data (unweighted) for the non-magnetic heavy mineral separates from the -60+230 (-250+62.5 μm) mesh fraction of regional till samples from the Canfield Creek survey. Data weighted according to the method of Toverud (1982), see text for discussion.

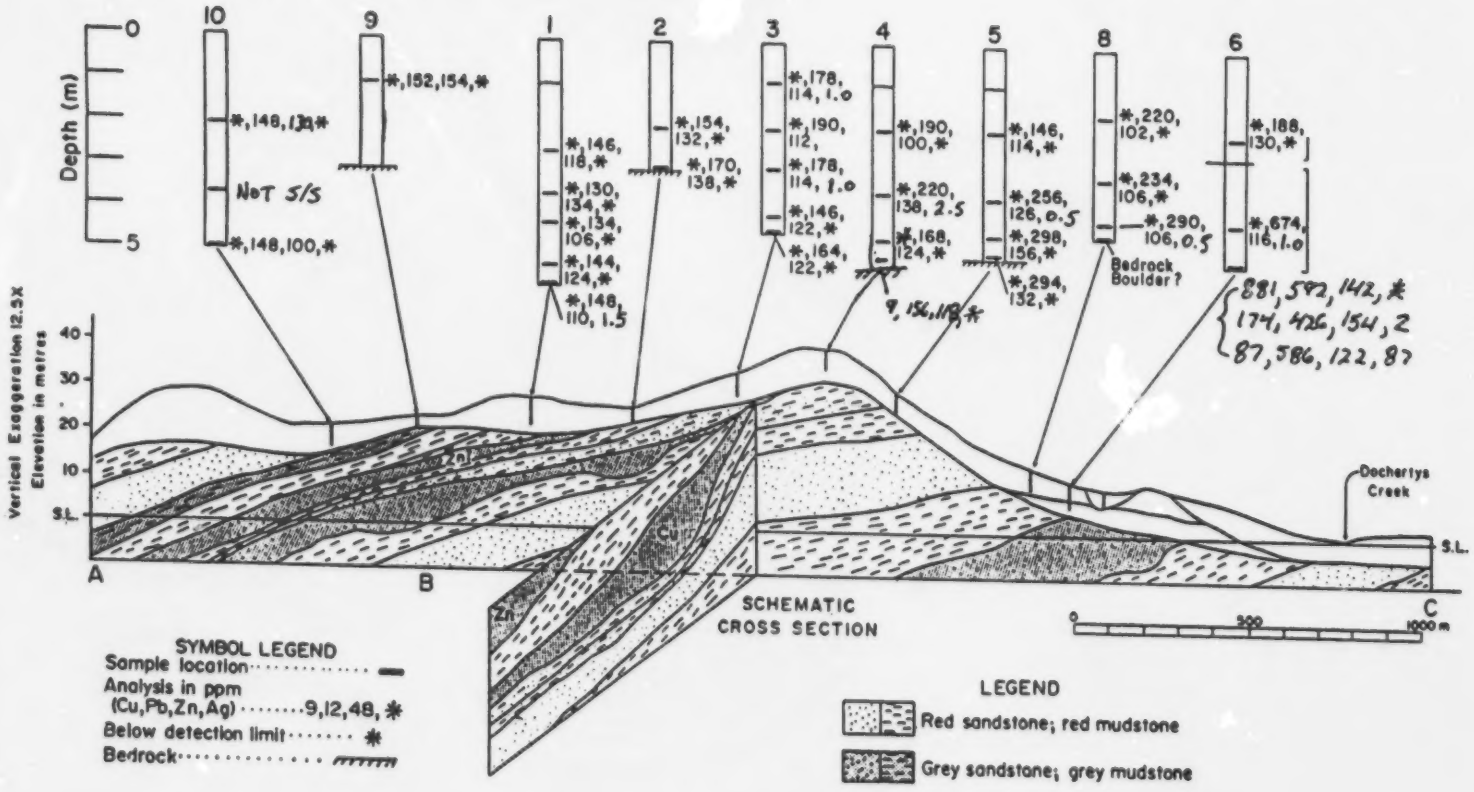

Figure 20a. Plot of unweighted Cu, Pb, Zn and Ag data for the non-magnetic heavy mineral separates from the -60+230 mesh fraction of till samples from the Canfield Creek trench survey.

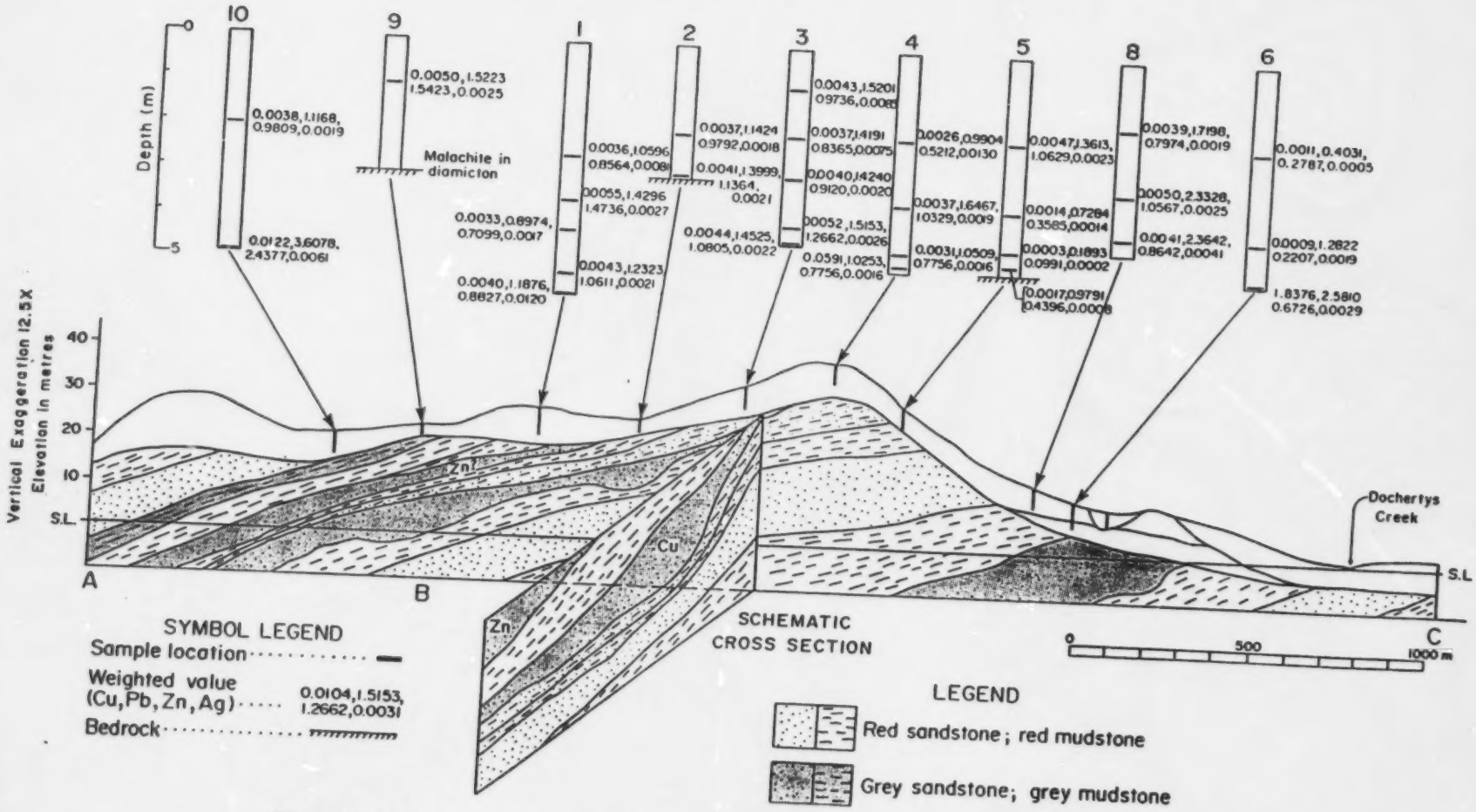

Figure 20b. Plot of weighted data (Cu, Pb, Zn and Ag) for the non-magnetic heavy mineral separates from the -60+230 (-250+62.5 μm) mesh fraction of till samples from the Canfield Creek trench survey. Data weighted according to the method of Toverud (1982), see text for discussion.

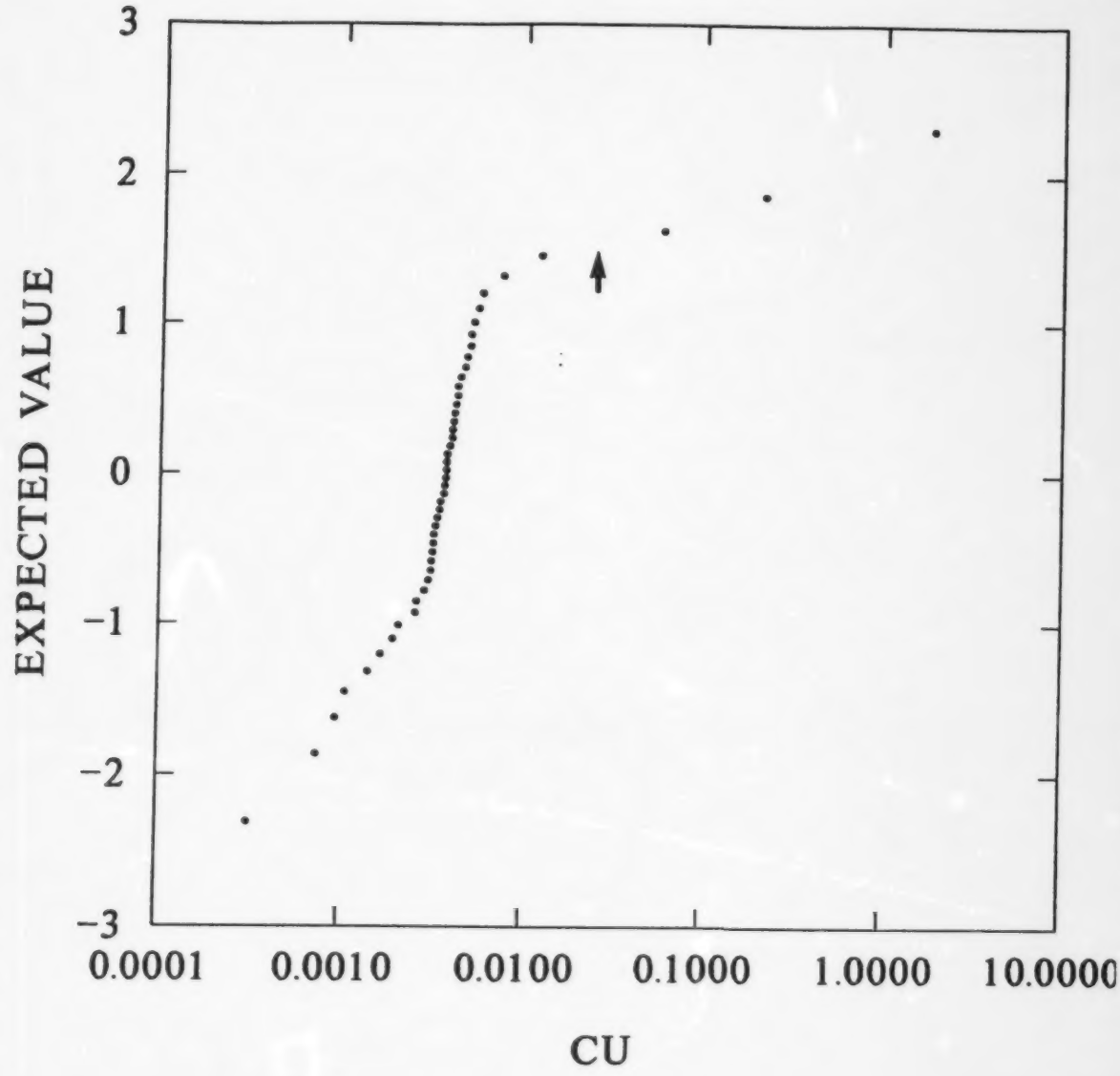

Figure 21a. Cummulative probability plots for Cu (weighted) from the heavy mineral concentrates from the -60+230 mesh fraction of till samples from the regional and trench surveys.

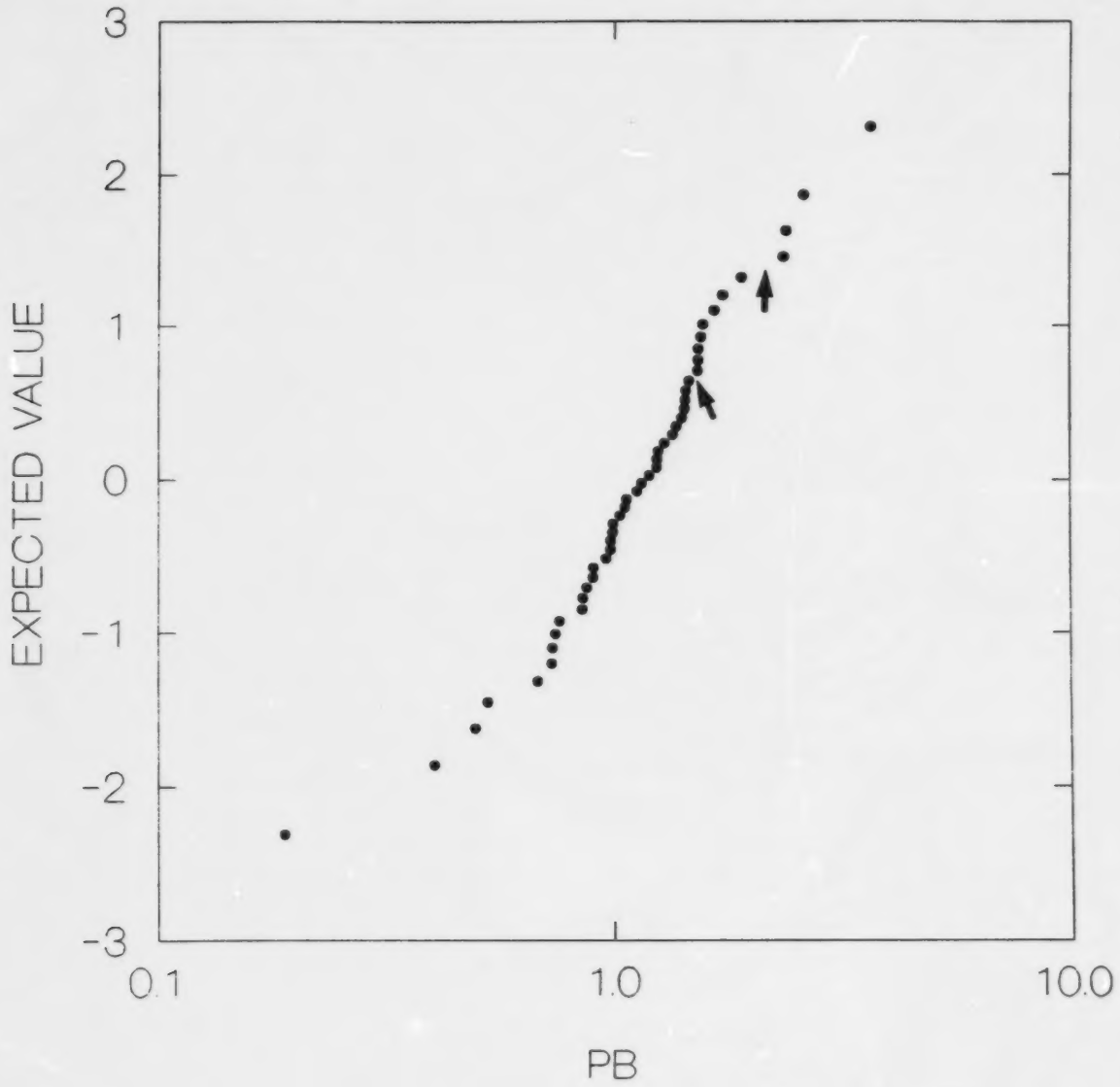

Figure 21b. Cummulative probability plots for Pb (weighted) from the heavy mineral concentrates from the -60+230 mesh fraction of till samples from the regional and trench surveys.

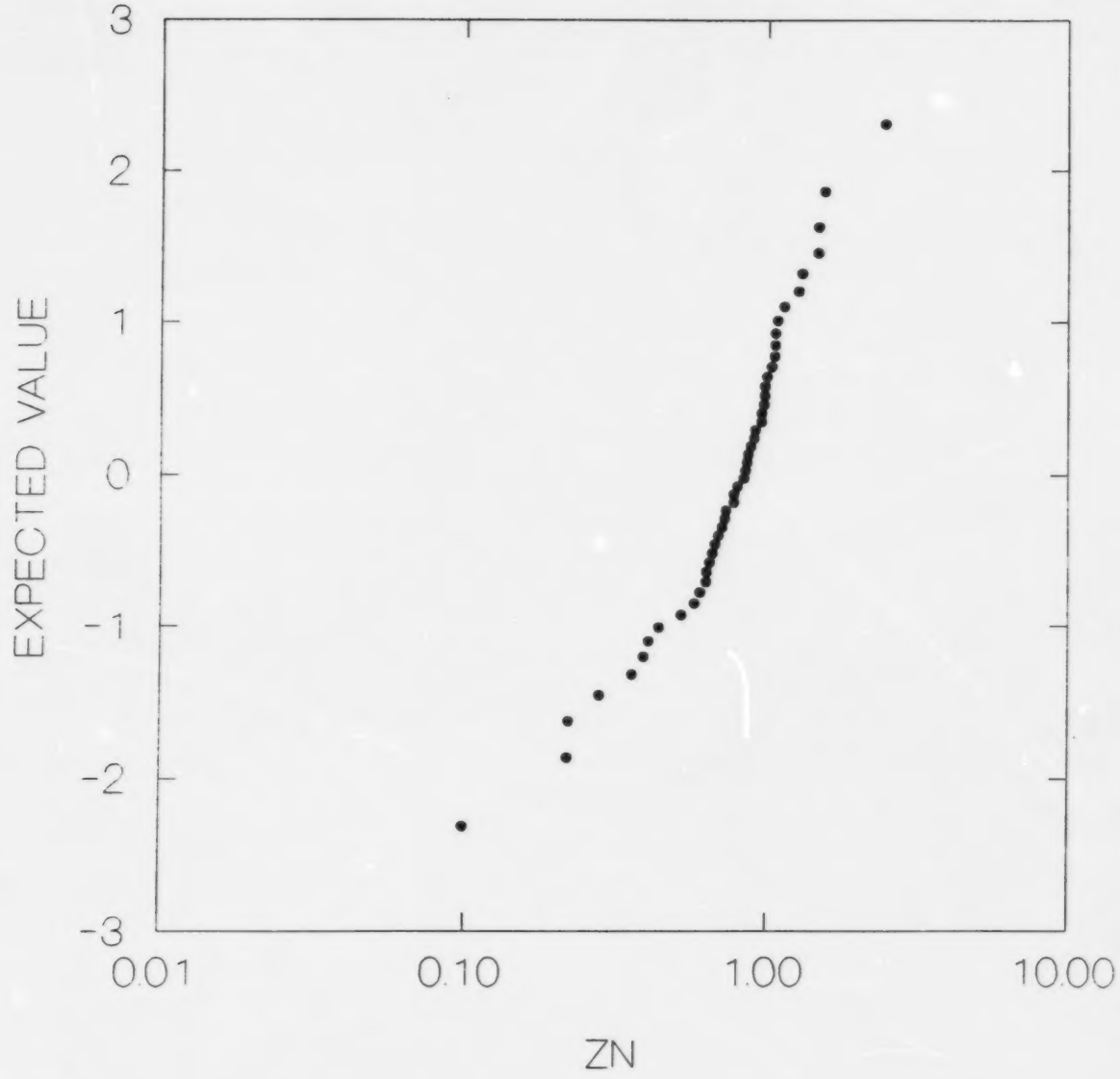

Figure 21c. Cummulative probability plots for Zn (weighted) from the heavy mineral concentrates from the -60+230 mesh fraction of till samples from the regional and trench surveys.

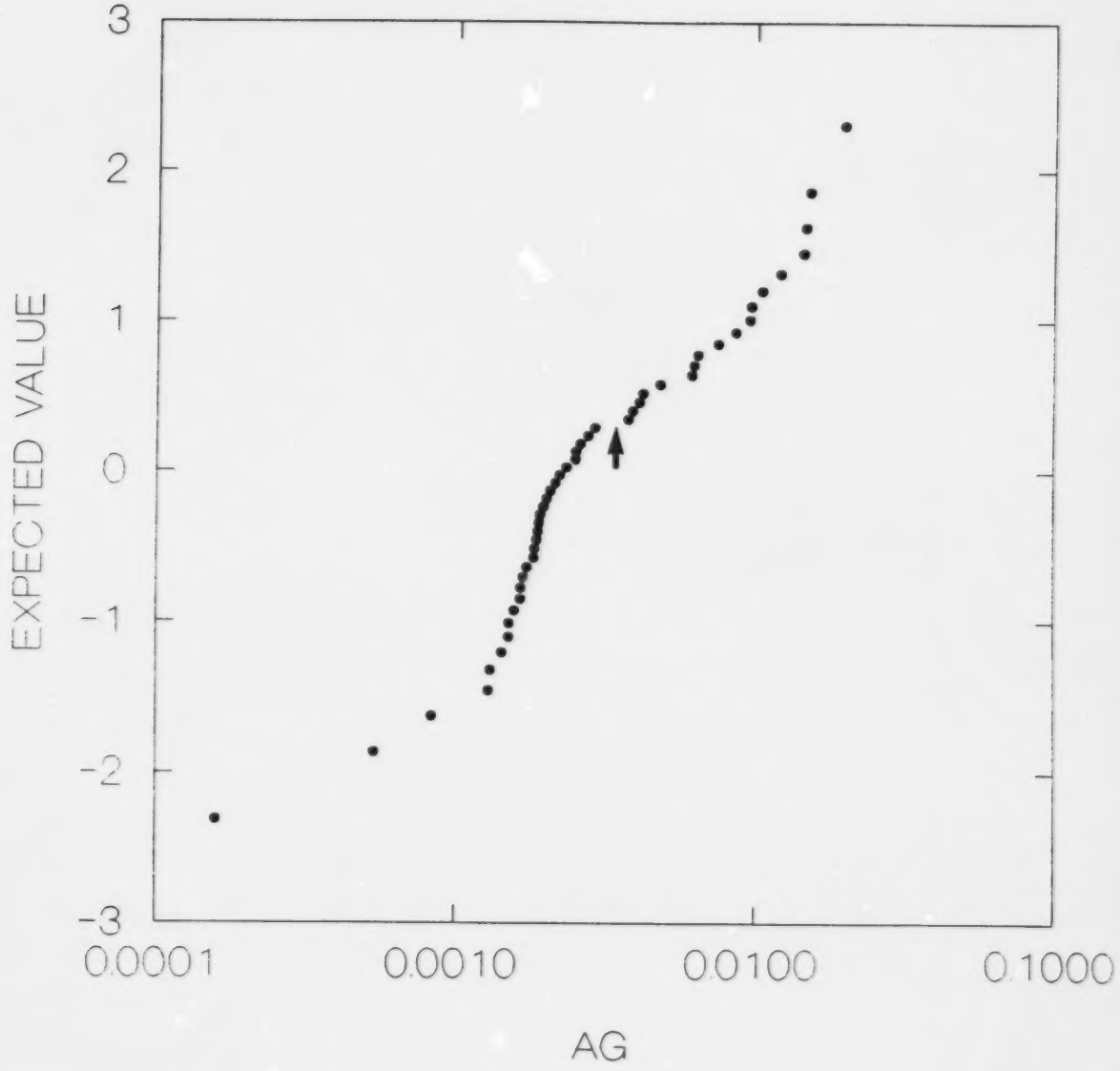

Figure 21d. Cummulative probability plots for Ag (weighted) from the heavy mineral concentrates from the -60+230 mesh fraction of till samples from the regional and trench surveys.

that the data from this survey represents a single population with no high or low "outlier" samples. The highest Zn value (3.61 weighted ppm) is for a sample from trench #10 (4.8 m depth). Interestingly this sample also has the highest Pb value. The higher concentrations within the data set (e.g. > 1.0 weighted ppm) are from the trench samples (1, 2, 3, 4, 5, 8, 9 and 10) and regional samples 2 and 11 from the Conns Mills area. The samples with the lowest weighted concentrations for Zn include CC-90-4 and 5 taken approximately 1.5 km southwest of the deposit, CC-90-17 from Pugwash Junction and trench #5 (3.5 m) from just "up-ice" of the deposit.

Unweighted Ag concentrations in the regional survey ranged from 0.3 ppm (i.e. detection limit) to 3.5 ppm. A cumulative probability plot for Ag is given in Figure 21d. A "break" in the data is indicated by an arrow. The samples from the upper "population" ubiquitously have concentrations of Ag above the detection limit of 0.5 ppm. The samples from the lower "population" are mostly those samples with <0.5 ppm Ag whereas a couple have >0.5 ppm Ag (e.g. CC-90-17 and trench #4- 2.0 m depth). The normal distribution "curve" for the data below the arrow is reflecting changes in the respective yields of heavy minerals, not variations in Ag concentrations. No systematic variation were noted between Ag concentrations and proximety to the subcrop of the Canfield Creek deposit. It should be noted that the three highest values of Ag (>1.014 weighted ppm) are in samples CC-90-5, -7 and -14 which were collected south, and southwest of the deposit.

Most other trace and major elements were very similar in concentration in both the regional and detailed trench surveys. A notable exception is Ba which ranges from 160-390 ppm in the regional survey and 390-13300 ppm in the trench survey. No Ba-enrichment has been previously reported in the Canfield Creek deposit and therefore the origin of the increase is presently unclear.

In summary, there are no apparent positive or negative "anomalies" for Cu, Pb, Zn or Ag in the non-magnetic heavy mineral separates near the Canfield Creek deposit. The heavy mineral data has a somewhat erratic distribution with very "spotty" high and low values. The Cu concentration in the samples of grey sandstone-dominated McCarron Brook till from trench #6 are substantially higher than in the Eatonville till where only 2 samples had levels above the detection limit (1 ppm). The high Cu in the McCarron Brook till is in accord with the data from the -230 mesh fraction. The lack of positive Cu anomalies in the heavy mineral till concentrates may reflect a lack of Cu mineralization. Conversely, the tendency for chalcocite and digenite to alter to malachite in the surficial environment could explain the absence from heavy mineral concentrates.

8.2 Biogeochemistry

The ashed Balsam fir samples were sent to ACME Analytical Laboratories Ltd. of Vancouver, British Columbia for analysis. The sample digestion and analytical procedures were the same as those of Dunn et al. (1989). Approximately 0.25-0.50 gms of ash were digested in hot HCl-HNO_3-H_2O for 1 hour and then diluted with 10 ml H_2O. This extraction is partial for Mn, Fe, Sr, Ca, P, La, Cr, Mg, Ba, Ti, B, W and limited for Na, K and Al. The samples were then analysed for a suite of 30 trace elements by ICP-AES. Results for

Mo,Au,La and W were entirely below detection limits (1,3,2 and 1 ppm respectively) and were disregarded. Most Bi values ranged from 2-5 ppm and were also not reported because of poor precision below 5 ppm (Dunn pers com. 1991). The analytical results for the remaining 25 elements (Cu, Pb, Zn, Ag, Ni, Co, Mn, Fe, As, U, Th, Sr, Cd, Sb, V, Ca, P, Cr, Mg, Ba, B, Al, Na, K) are given in Table 4a of Appendix A. As noted in the previous section, Ba will precipitate as insoluble BaCl in the presence of HCl. Therefore, Ba values are presumably much lower than true concentrations.

Analytical results for the standards, analytical sample splits and field duplicates are given in Tables 4b-d of Appendix A. In general, the precision and accuracy for much of the data is acceptable. In contrast, the quality of the fourth standard and the third and fourth sample splits are very poor with discrepancies of up to several hundred percent for many elements. In spite of recognition of these problems with the data, there was insufficient ash to reanalyse the sample set. Therefore only the most pronounced trends in the data are deemed significant. More subtle trends may simply be artifacts of poor analytical precision.

Analytical results for Cu, Pb, Zn and Ag for the Balsam fir samples from the entire study area are presented in Figure 22. Unfortunately, Balsam fir could only be collected at 4 of the 10 trench locations (i.e. trenches 2, 6, 7 and 10) and no samples were available directly over the deposit (i.e. trenches 3, 4, 5). However, some preliminary observations regarding the biogeochemical response of the Canfield deposit can be made.

A cumulative probability plot for Cu is presented in Figure 23a. There are three outlier samples with >230 ppm Cu. One sample (trench #2) is located just "down-ice" from the deposit and may reflect some enrichment from glaciated Cu mineralization. However, the other two samples (CC-90-13, -18) were not collected near known mineralization. There appears to be two separate populations within the remainder of the data. These populations are separated at approximately 170 ppm Cu. The samples from these two populations are interspersed throughout the study area and bear no correlation with proximity to the Canfield ore zone.

The cumulative probability plot for Pb for the Balsam fir data is given in Figure 23b. The observed distribution of data suggests the presence of two populations that are separated at approximately 55 ppm. The location of the samples from the lowermost population are somewhat random but mostly located south or south east of the deposit (trench #10; CC-90-14, -16) and north of the deposit (trench #8; CC-90-06). In spite of a high concentration of Pb near the deposit (trench #2; 106 ppm Pb) these low concentrations are interpreted as representing a slight negative "anomaly" near the deposit.

The cumulative probability plot for Zn (Fig. 23c) also indicates the presence of two possible populations in the Canfield data set. Most samples from the population with the higher concentrations (>1800 ppm) are located around the perimeter of the survey area and directly "down-ice" from the deposit in trench #2. In contrast most of the samples from the population with the lower concentrations were collected in the vicinity of the deposit. Therefore, the Zn data resembles the Pb data and defines a slight negative "anomaly" near the deposit.

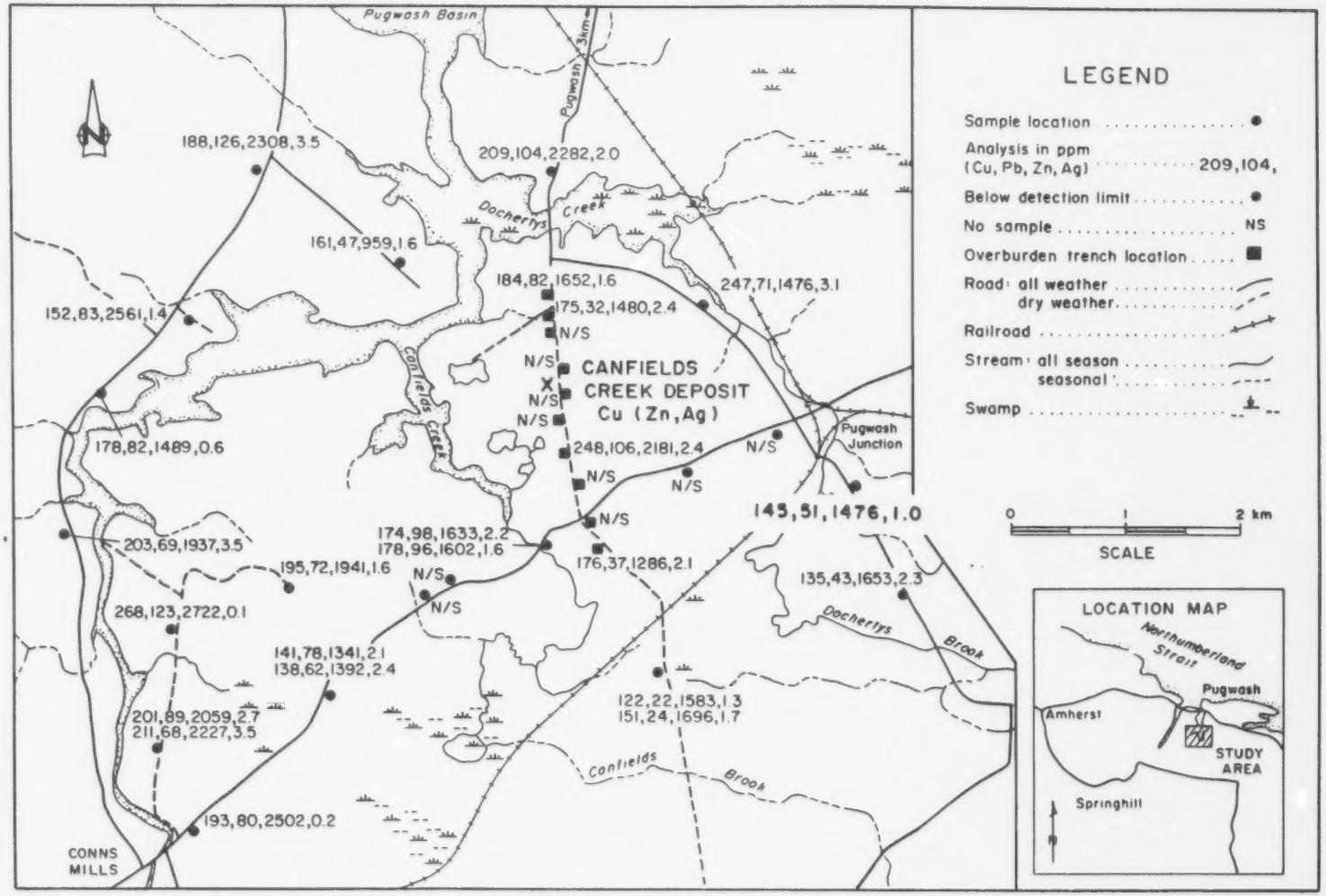

Figure 22. Plot of Cu, Pb, Zn and Ag data for ashed Balsam Fir from the regional and trench surveys at Canfield Creek.

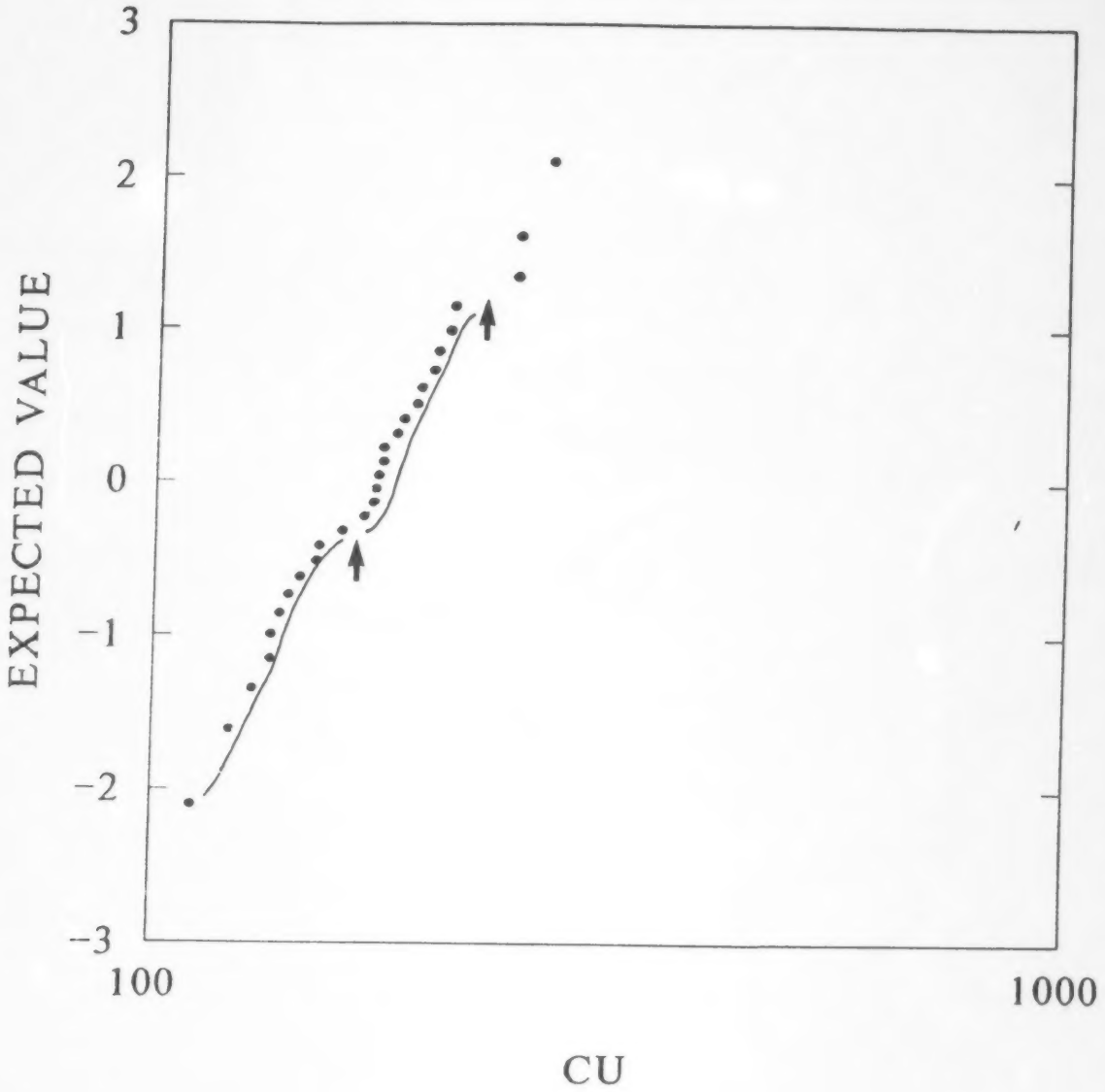

Figure 23a. Cummulative probability plots for Cu from ashed Balsam fir samples from the regional and trench surveys.

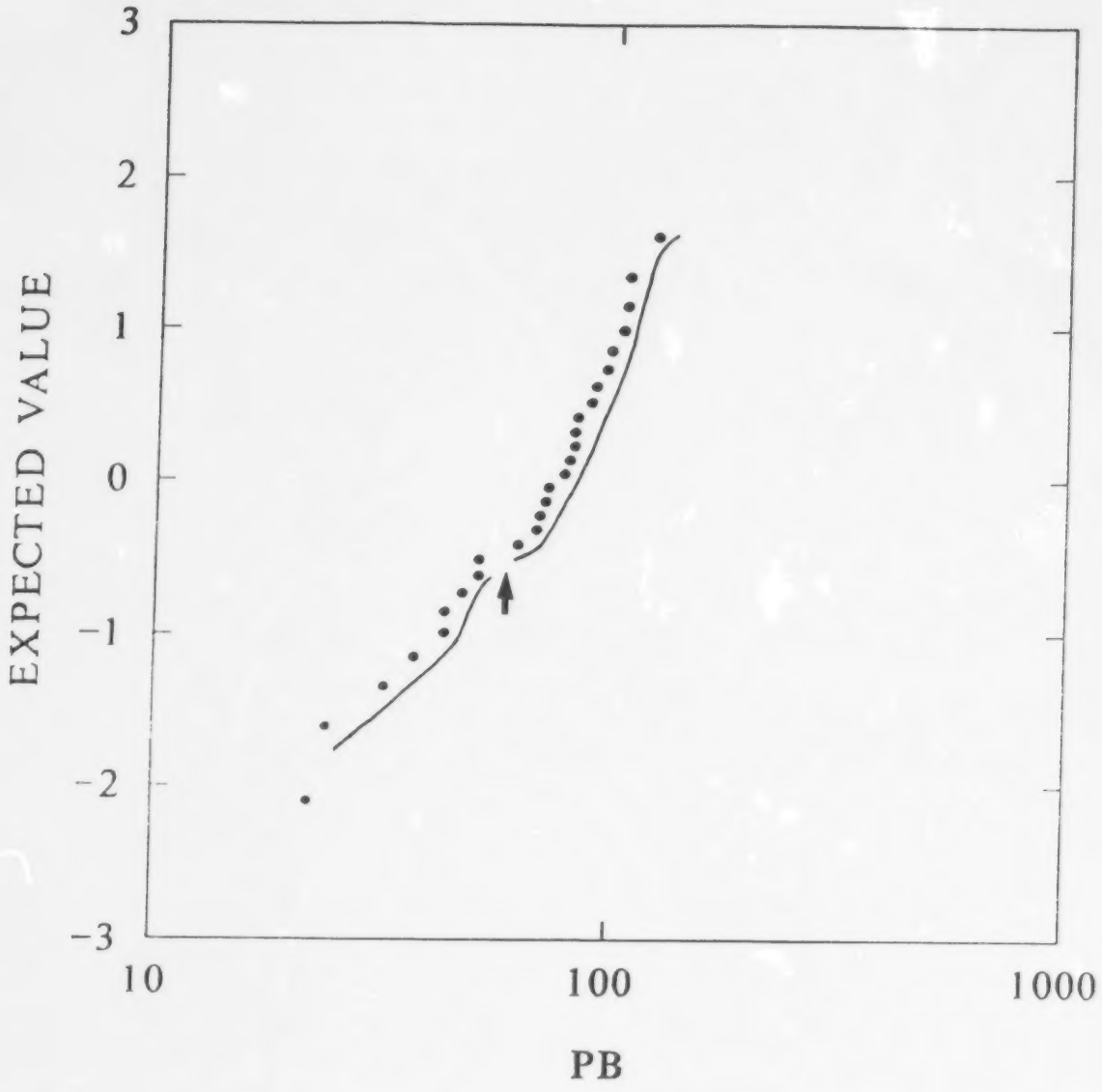

Figure 23b. Cummulative probability plots for Pb from ashed Balsam fir samples from the regional and trench surveys.

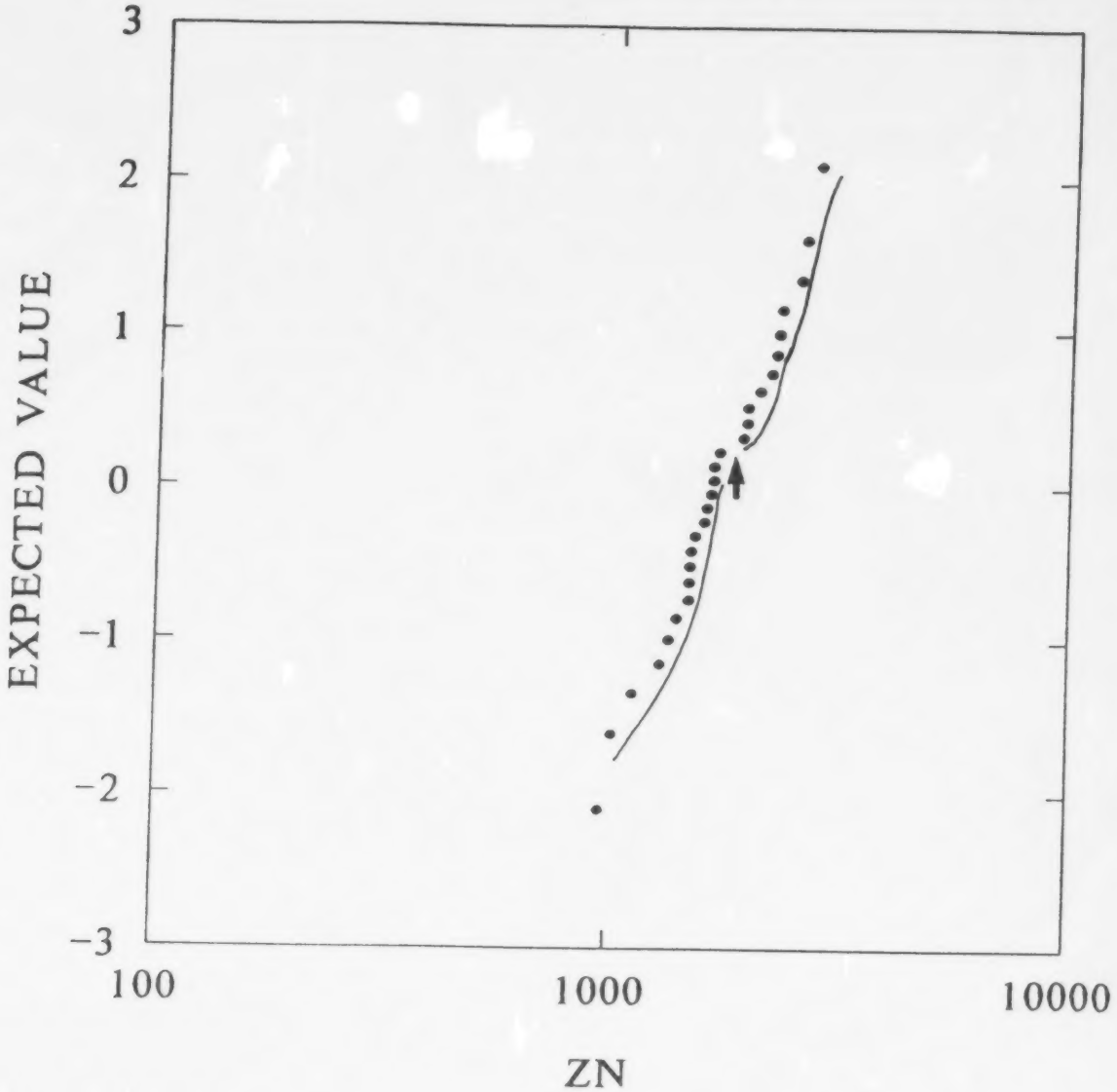

Figure 23c. Cummulative probability plots for Zn from ashed Balsam fir samples from the regional and trench surveys.

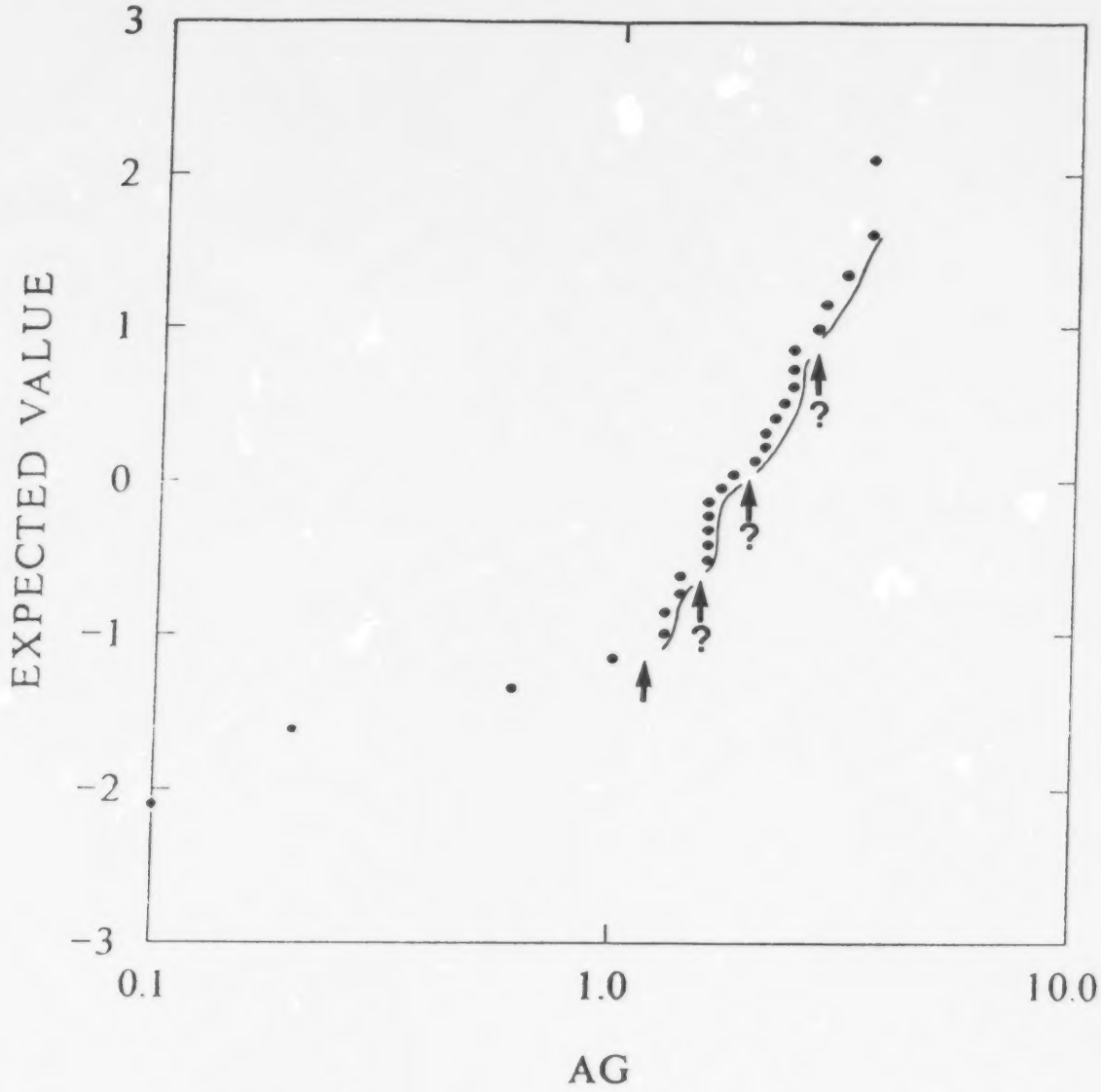

Figure 23d. Cummulative probability plots for Ag from ashed Balsam fir samples from the regional and trench surveys.

The distribution of the Ag data for Balsam fir is shown in Figure 23d. There are 4 outlier samples with substantially lower concentrations that the bulk of the samples (see arrow in Fig. 23d). These samples, which include CC-90-1, 9, 10 and 17, were collected in the southwestern and eastern portions of the study area and as such do not represent a negative "anomaly" in association with the Canfield deposit. The bulk of the data shows an erratic distribution. There are three slight breaks in the data that correspond to 1.5, 1.9 and 2.5 ppm Ag respectively. These breaks (marked with arrows and question marks in Fig. 23d) may define four separate populations, although these features more likely represent normal variations within a single population. The data from each of the groups in Figure 23d are erratically distributed throughout the study area and show no systematic variation with proximity to the deposit.

In summary, no positive anomalies (Cu, Pb, Zn or Ag), near the Canfield Creek Cu-Ag deposit, were evident in the Balsam fir data. However, slight depletions in Pb and Zn in the central portion of the study area may represent slight negative anomalies.

8.3 Humus

The -80 (-177 μm) mesh fraction of the oven-dried organic humus ("A" soil horizon) samples were sent to Bondar Clegg Company Ltd. of Ottawa Ontario for analysis by the 38 element ICP-AES analytical package. This is the same technique that was employed for the -230 (-62.5μm) mesh fraction of till samples. Approximately 0.5 gm of sample was digested in a LeFort Aqua-Regia (HCl-HNO_3, 1:3) digestion prior to analysis.

Many elements were either entirely below detection limits or were present in such low concentrations that analytical precision was very poor. These elements include Ti, Na, P, Li, Be, Ga, Rb, Y, Zr, Nb,As, Cd, Mo, Sn, Sb, Te, La, Ce, Ta, W and Bi. Analytical results for the remaining 17 elements (Cu, Pb, Zn, Ag, Ni, Co, Mn, Fe, Sr, V, Ca, Sc, Cr, Mg, Ba, Al and K) are given in Table 5a of Appendix A. Analytical data for standards, sample splits and field duplicates are given in Tables 5b-d respectively.

Analytical data for Cu, Pb, Zn and Ag for A-horizon organic humus samples from the study area are given in Figure 24. Humus was available at all sampling locales except at trenches 5, 6 and 9. A cumulative probability plot for Cu (Fig 25a) shows a single population with no obvious breaks in data distribution or outlier samples. In general there is no systematic variation of Cu concentration throughout the study area. However, it was noted that humus samples from the area near, and "down-ice" from, the deposit have some of the lowest Cu concentrations (3-6 ppm). This contrasts with higher values ($\geq$14 ppm) that are erratically distributed elsewhere in the study area. These consistently lower Cu values in humus near the deposit may represent Cu depletion near the deposit. The highest Cu values occur over trench #7 and in sample CC-90-7 approximately 3.5 km northwest of the deposit (14 ppm in both). Trench #7 is located approximately 1 km north (i.e. "up-ice") from the deposit in a low-lying swampy area that is underlain by unconsolidated marine(?) sands and a buried peat bed. It is possible that the elevated Cu in this sample may be hydromorphically concentrated although concentrations of Fe and Mn, which are typical hydromorphic "scavengers" (levinson, 1974), are not notably elevated.

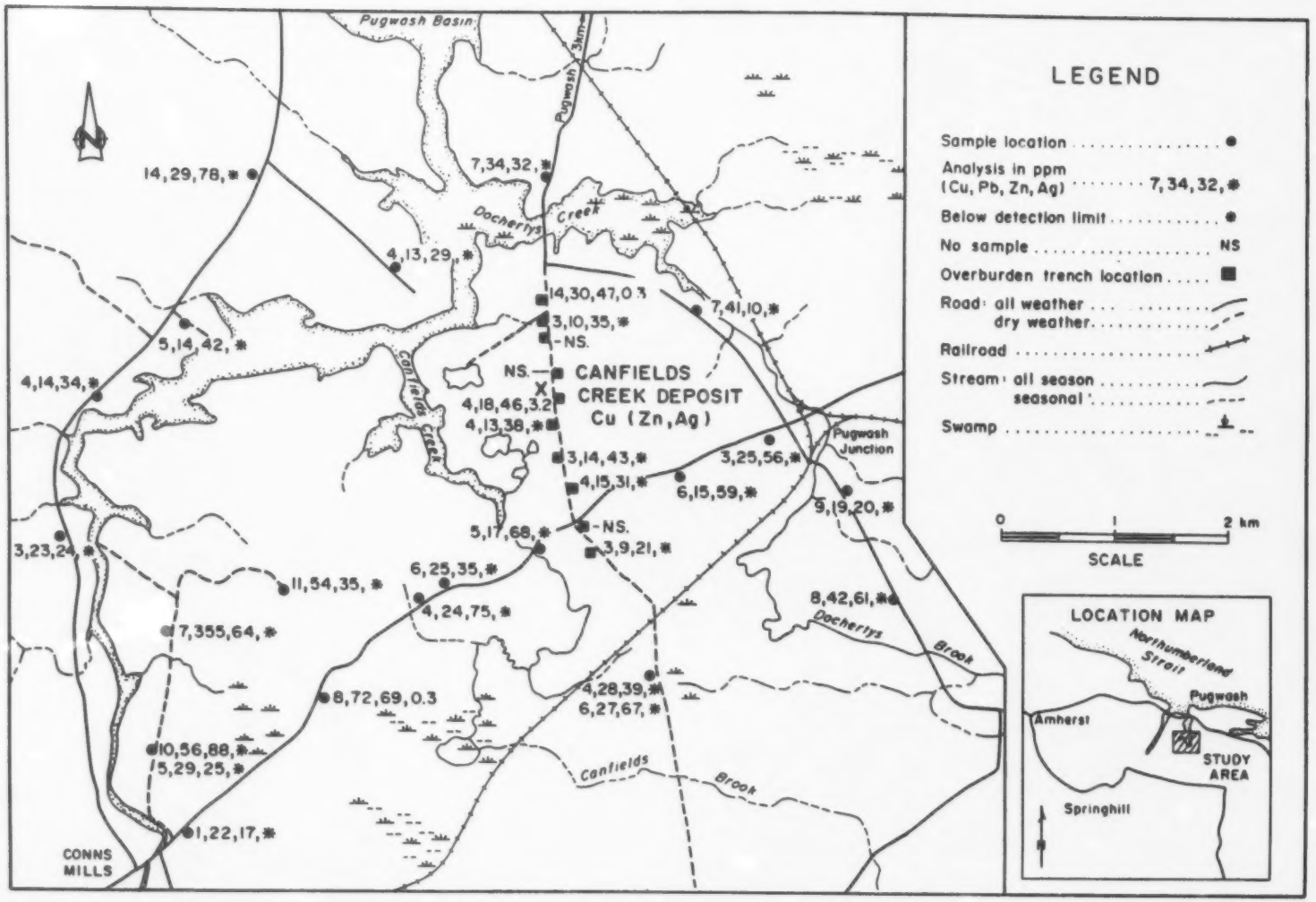

Figure 24. Plot of Cu, Pb, Zn and Ag data for the -80 mesh fraction of humus from the regional and trench surveys.

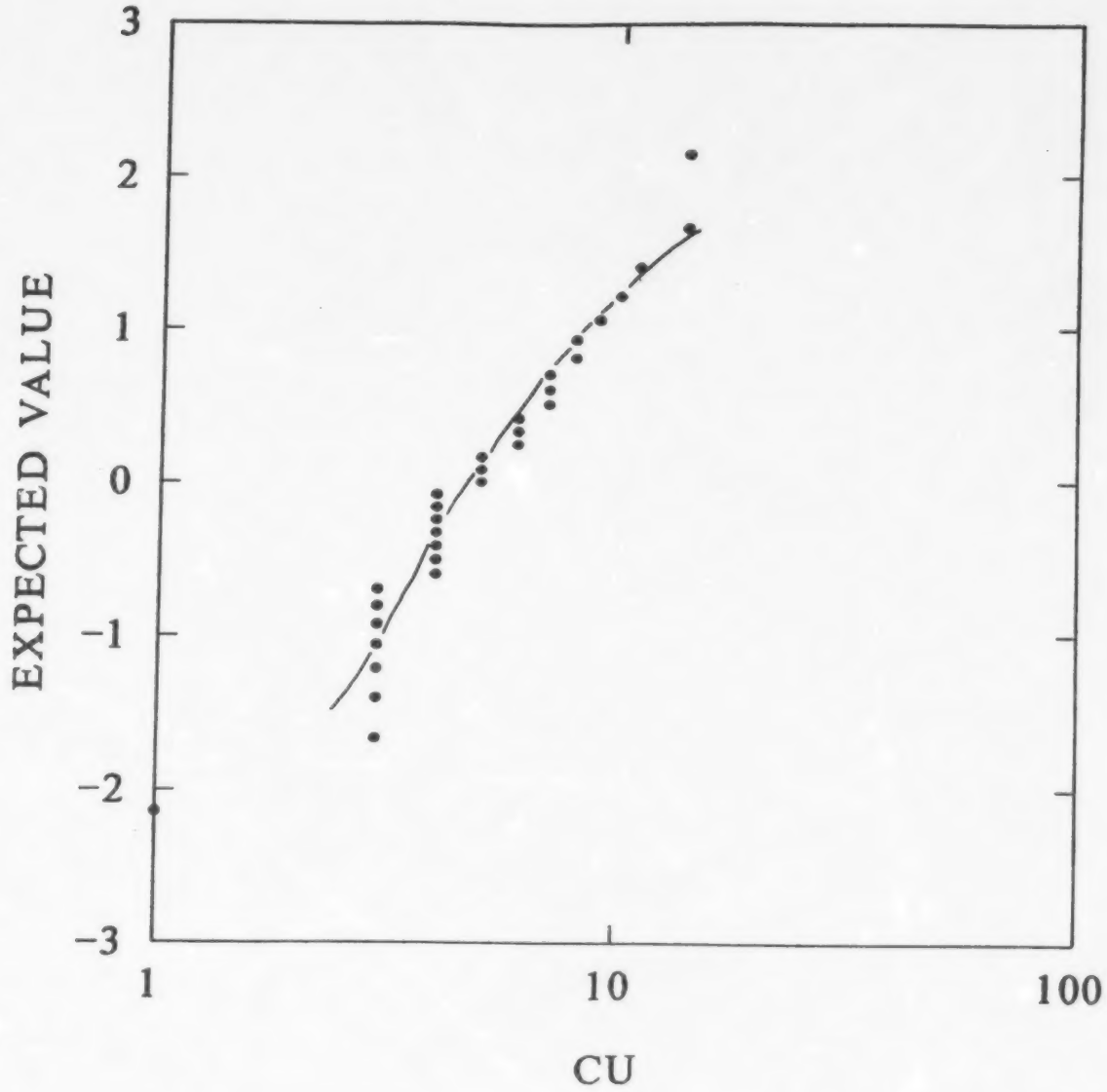

Figure 25a. Cummulative probability plots of Cu from the -80 mesh fraction of humus from the regional and trench surveys.

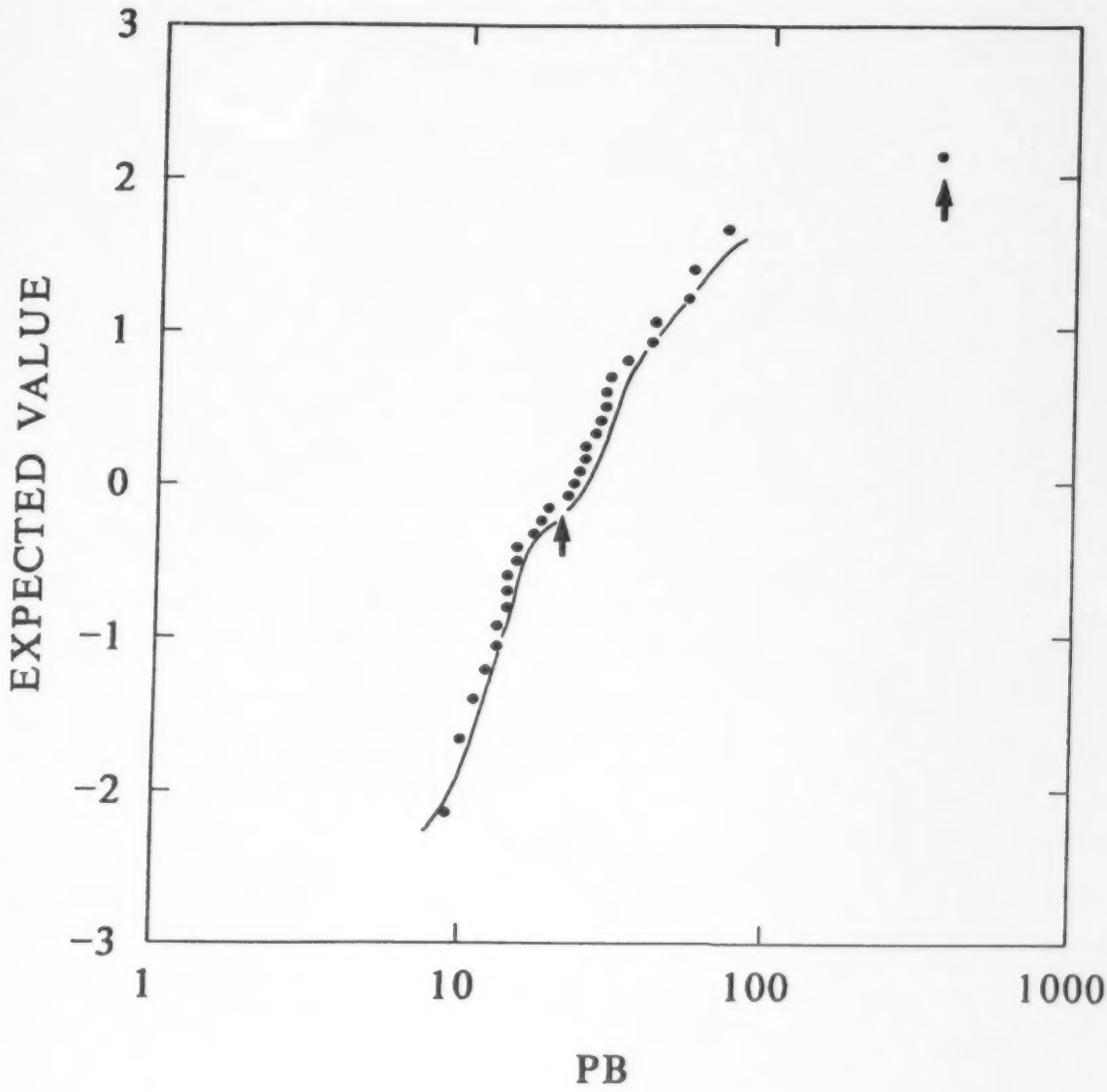

Figure 25b. Cummulative probability plots of Pb from the -80 mesh fraction of humus from the regional and trench surveys.

A cumulative probability plot for Pb data from the Canfield Creek deposit is given in Figure 25b. There is one "anomalous" or outlier sample (CC-90-13) with 355 ppm Pb. Interestingly, the Balsam fir and both fractions of till taken at this same locale are not enriched in Pb compared to the remainder of the data sets. There is an apparent break in the main portion of the data set at approximately 20 ppm. All of the samples from the population with the highest concentrations (i.e. >20 ppm) were collected along the northern and southern sections of the study area. All of the samples from the lower population (i.e. <20 ppm) were collected from Pugwash Junction, over the Canfield deposit to the west-central part of the study area. Some of the lowest Pb values were collected directly "down-ice" or south of the projected subcrop of the Canfield deposit (trenches 2, 3 and 4; 15, 14 and 13 ppm Pb respectively). The observed distribution for Pb in humus resembles that for the Balsam fir data and suggests the presence of a weak to moderate "negative anomaly".

A cumulative probability plot for Zn in humus is shown in Figure 25c. There are two main breaks at approximately 27 and 52 ppm Zn, thus dividing the data into three potential populations. With the exception of one sample in the northwest corner of the study area (CC-90-07; 78 ppm), all of the samples with concentrations of Zn ranging from 56 to 88 ppm occur in a zone from Pugwash Junction to Conns Mills. The rest of the study area has interspersed samples from both of the lower populations. In contrast to the Pb data for humus the lowest Zn concentrations do not occur at or near the deposit. However, in general the area around the deposit is depleted in Zn (negative anomaly?).

Concentrations of Ag are very low (i.e. near or below detection limit of 0.2 ppm) in virtually all regional and trench samples. However, one outlier sample (arrow in Fig. 25d) collected near the projected Canfield ore zone (trench #4), has 3.2 ppm Ag. The origin of this enrichment in Ag is somewhat enigmatic in light of the low Ag values in both the -230 (-62.5μm) mesh fraction and heavy mineral concentrate (-60+230 (-250+62.5 μm) mesh fraction) from the till in and around trench #4. Two intermediate outlier samples (second arrow in Fig. 25d), each with 0.3 ppm Ag, were collected at trench #7 and CC-90-02 near Conns Mills.

In summary, the Cu, Pb, Zn and Ag concentrations in the humus vary significantly in their respective distributions. Pb and to a lesser extent Zn data define weak depletion zones near the Canfield deposit (negative anomalies?). Copper is much more erratically distributed, although the area around the deposit also has some of the lowest Cu values. A positive Ag anomaly over the deposit is defined by a single sample (3.2 ppm), although a sample taken approximately 200 m "down-ice" from this location returned <0.1 ppm Ag, indicating the "anomaly" has little lateral extent.

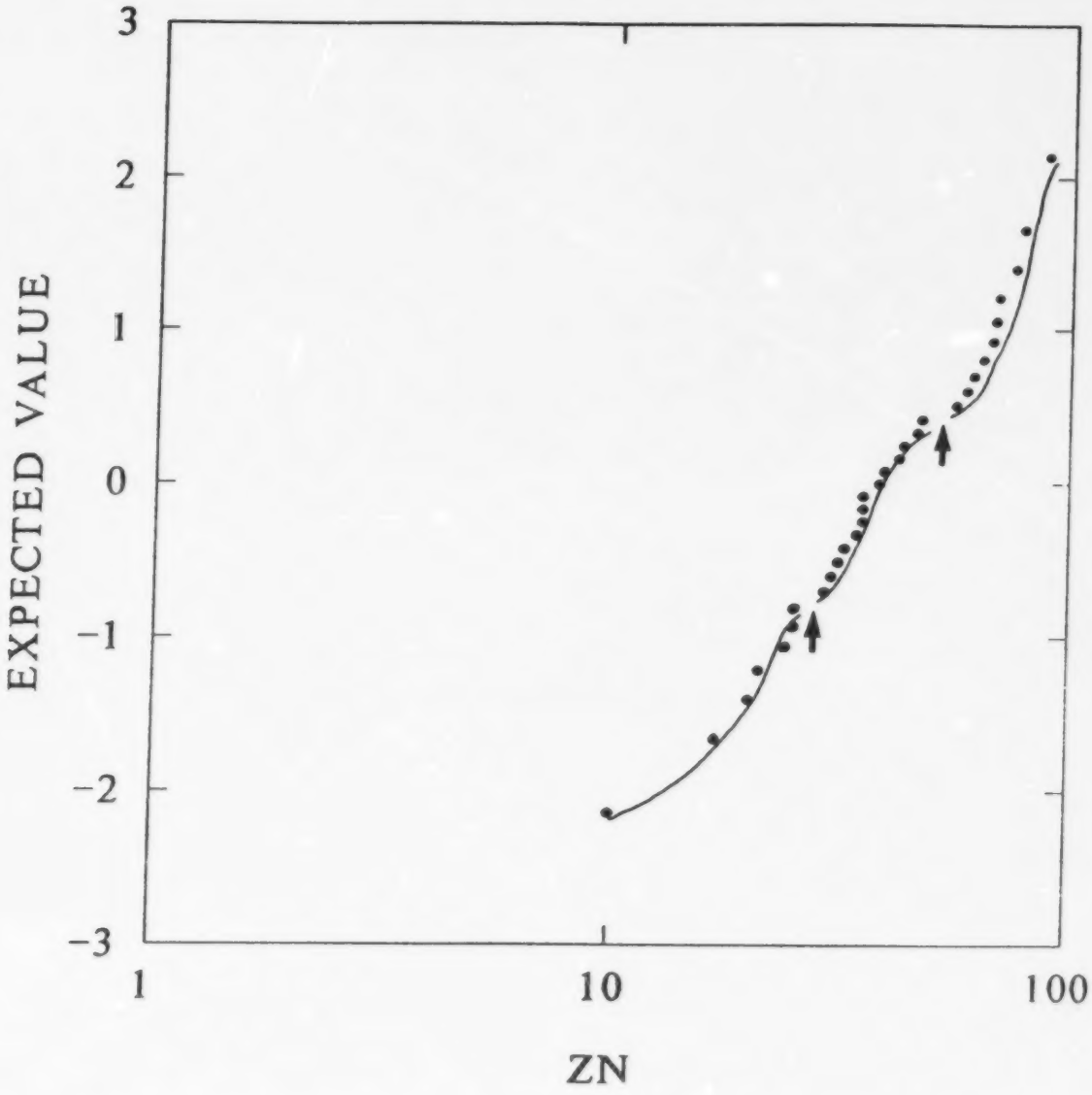

Figure 25c. Cummulative probability plots of Zn from the -80 mesh fraction of humus from the regional and trench surveys.

CANFIELDS CREEK REGIONAL SURVEY 1990 HEAVY MINERALS

SAMPLE NUMBER		CC-90 1	CC-90 2	CC-90 4	CC-90 5	CC-90 6	CC-90 7	CC-90 8	CC-90 9	CC-90 10	CC-90 11	CC-90 12	CC-90 13	CC-90 avg.14	CC-90 15
Ag	ppm	1.5	.25	1.0	3.5	0.5	2.5	.25	1.0	0.5	1.7	1.0	.25	1.6	1.5
Al	%	3.97	6.56	3.64	4.67	3.30	4.33	4.57	4.02	3.91	3.60	4.57	4.48	4.26	3.05
Ba	ppm	310	390	160	280	280	230	210	230	340	310	210	250	275	450
Ca	%	0.41	0.37	0.91	0.33	1.84	1.14	1.72	0.86	1.55	1.01	1.51	1.05	0.31	2.40
Cd	ppm	1.0	0.5	0.3	0.5	0.5	0.5	0.3	0.3	1.5	1.0	0.5	1.0	2.0	1.0
Co	ppm	12	14	3	10	12	6	11	12	11	11	10	5	19	8
Cr	ppm	183	130	184	177	184	162	216	169	196	192	161	171	139	179
Cu	ppm	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	23	0.5
Fe	%	28.16	23.16	22.31	22.23	24.95	24.79	23.36	23.90	25.81	24.75	21.70	22.14	24.085	21.36
K	%	0.67	1.34	0.46	0.82	0.46	0.64	0.53	0.60	0.70	0.535	0.57	0.56	0.74	0.36
Mg	%	0.46	0.57	0.61	0.48	0.53	0.67	0.77	0.65	0.52	0.48	0.81	0.69	0.51	0.56
Mn	ppm	7440	10950	9610	9750	8475	7275	14640	7040	6965	8398	8565	14115	9500	7355
Mo	ppm	3	2	1	1	2	1	1	2	4	2	1	1	2	1
Na	%	0.24	0.36	0.26	0.28	0.26	0.27	0.26	0.24	0.25	0.23	0.33	0.29	0.31	0.29
Ni	ppm	18	27	21	21	19	28	24	21	22	21	19	17	25	18
P	ppm	1220	1920	2050	2180	3980	900	1720	810	3760	1645	1590	1760	2200	5460
Pb	ppm	192	104	128	178	130	148	130	136	184	164	154	132	131	114
Sr	ppm	126	177	138	161	134	170	223	140	173	127.5	192	156	181	163
Ti	%	8.28	7.39	15.44	12.71	9.47	10.84	13.73	8.58	8.86	8.29	14.95	13.85	14.17	9.66
V	ppm	459	272	497	348	588	416	424	438	533	503	376	411	269	579
W	ppm	20	10	30	20	30	30	40	30	30	45	20	40	20	40
Zn	ppm	104	98	105	94	100	110	138	108	114	113	104	112	106	98
Zr	ppm	4710	5750	11170	13000	5330	6600	10300	6080	5000	5275	8230	6000	8390	3480

Table 3a. Unweighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

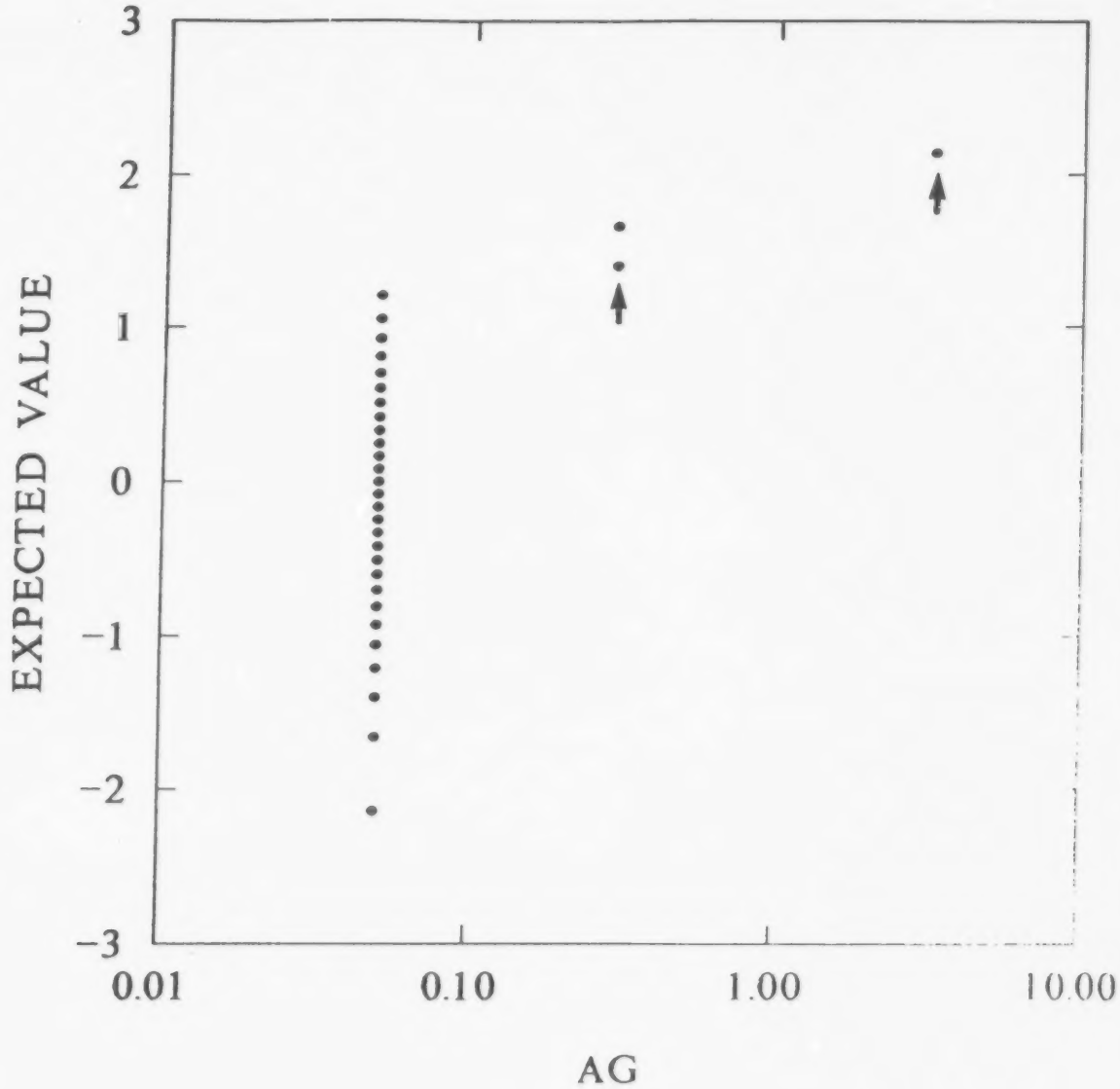

Figure 25d. Cummulative probability plots of Ag from the -80 mesh fraction of humus from the regional and trench surveys.

9 DISCUSSION AND CONCLUSIONS

MacDonald et al. (1991) conducted a multi-media follow-up geochemical study over the east zone of the Yava Pb mine, a Carboniferous aged sandstone-hosted deposit in eastern Cape Breton Island. They concluded that the Yava deposit has a robust geochemical signature (Pb,Zn,±Cd±Ag) that was clearly defined in all sample media including till (both -230 (-62.5μm) mesh fraction and -60+230 (-250+62.5 μm) mesh fraction heavy mineral separates), A-horizon organic humus and Balsam fir (both twigs and needles). A 1st° and 2nd° stream that crossed the study area was noted to contain highly anomalous concentrations of the above elements. These workers concluded that a subcropping Yava-type deposit could be successfully located using stream sediment survey (-230 (-62.5μm) silt and clay fraction) using a sample spacing of 2 km. This supports the findings of Rogers and MacDonald (1984a). They also noted that the deposit could be further delineated using a grid survey spacing of approximately 1 km for till, humus or biogeochemical surveys.

The sampling methods, sample preparation and analytical techniques for this study are identical to those of MacDonald et al. (1991). In addition, this survey employed detail trenching over the projected subcrop of the Canfield deposit. Considering the tonnage and grade of the Canfield deposit (300 000 tons @ 1.2% Cu; O'Sullivan, 1981) the results from this study are somewhat perplexing. A summary of the geochemical responses for the various sampling media is presented in Table 6. In general, the Canfield Creek Cu-Ag deposit lacks robust positive enrichment (i.e. positive anomalies) for "base metals". A few positive "anomalies" were noted for the various media but were "spotty" and of limited areal extent.

The results from this study reveal the presence of slight depletions (i.e. negative anomalies) in Cu, Pb and Zn in humus, and Pb and Zn in Balsam fir near the Canfield Creek deposit. The presence of these depletions over this solution-front deposit are in accord with the predicted geochemical behaviour (Ryan, 1988) as outlined in section 3.4. It should be stressed, however, that the decrease in concentration of these "base metals" in the various media may simply be a manifestation of higher content of red sandstone/mudstone in the Eatonville till near the deposit (Section 6.2). Lower concentrations of Cu have been previously been documented in red sandstone- versus grey sandstone-dominated tills (Stea et al. (1986). The chief question in the case of the Canfield Creek deposit is whether the high content of red sandstone in the overlying till reflects processes of mineralization (i.e. Triassic oxidation) or conversely the local stratigraphy. If the negative "anomalies" over the deposit reflect depletion from mineralizing processes, it is reasonable to predict that the majority of the mineralized strata are at depth and were not exposed during previous periods of glaciation. The increased content in grey sandstone clasts and the weakly developed ribbon-shaped, positive Cu anomaly in the trench survey presumably reflect residual mineralized (?) zones. These may have been preserved away from an advancing solution front, particularly if these zones contained high organic debris (Ryan, 1988). These findings indicate that if a target could be located using reconnaissance or detailed geochemical surveys (e.g. negative anomalies), a detailed trenching survey could further pin-point the exact location of anomalous horizons. This technique could therefore be an effective means of delineating drilling targets.

The McCarron Brook grey sandstone-dominated till unit that was intersected in trench #6

generally had the highest Cu, Zn and Pb values from either the trench or "regional" till surveys. This is consistent with the findings of Stea et al. (1986), who noted differences between red- and grey-dominated till units, and does not necessarily indicate the presence of mineralized strata "up-ice" from these till samples.

One notable geochemical feature is the apparent enrichment in Ba in heavy mineral concentrates from the trench till survey when compared to the regional survey. Barium is mobilized along with Cu during the reddening (i.e. mineralizing) process and is commonly found as barite cement in mineralized sandstones (Boehner pers. comm., 1991). However, barite is also found as a cement in unmineralized sandstone, thus, the use of Ba as a possible "pathfinder" element is somewhat limited.

As stated previously, the most significant elemental enrichment in the humus data is the high Ag value (3.2 ppm) for the sample from trench #4, directly over the ore subcrop. Most of the remainder of the regional and trench samples returned less than 0.2 ppm Ag (i.e. detection limit). Provided that this result can be replicated, Ag levels in detailed humus surveys may provide a suitable exploration "tool" for pin-pointing Canfield Creek-type deposits.

A vital consideration in conducting geochemical surveys is the relative time and cost efficiency of the various media. These parameters must be weighed against the respective effectiveness of these media as geochemical "tools". A summary of the sampling times, sample preparation and analytical costs for each of the media is given in Table 7. Although no stream sediment samples were collected during the Canfield Creek survey, this media has been included for comparison. As noted previously, analysis of the heavy mineral separates from the till samples was unsuccessful in defining either positive or negative "anomalies" near the deposit. Therefore this method of exploration is not recommended for future surveys that explore for this type of deposit. The most efficient method for future exploration, based upon our results, will combine biogeochemistry (e.g. Balsam fir), A_o organic humus and till sampling procedures. The following section outlines our recommendations for future work.

Table 6. Summary of geochemical response for the various sample media from the Canfield Creek deposit

	Cu		Pb		Zn		Ag	
	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
*Till matrix (-230 mesh)	*	-	-	-	-	-	-	-
*Till matrix (HM)	-	-	-	-	-	-	-	-
Ashed Balsam fir	*	-	-	*	-	*	-	-
Humus (-80 mesh)	-	*	-	*	-	*	*	-

*Explanation: Pos.- enrichment in element near deposit; Neg.- depletion in element near deposit; *-only till data from the red silty Eatonville till, data from McCarron Brook till discussed in text.*

Table 7. Table 7. Summary of sampling times, sample preparation and analytical costs for each sample media.

Sample medium	Approx. sampling time (in min.)	Sample preparation cost (Minerals Engineering Centre)	Analytical Cost
Stream sediment (-230)	15-45	- sieving $ 8.00 - homogenizing $ 2.00 Total $10.00	ICP - Bondar-Clegg - Aqua Regia $8.00
Stream sediment heavy mineral		- sieving $ 5.00 - H.L. separation $15.00 - mag. separation $ 3.00 Total $23.00	ICP - Chemex labs. - combined multi-acid digestion - ICP and Li-metaborite fusion - ICP - also re-dilute for high values $25.00
Till matrix (-230)	30-60	- sieving $ 8.00 - homogenizing $ 2.00 Total $10.00	ICP - Bondar-Clegg - Aqua Regia $8.00
Till matrix heavy mineral		- sieving $ 5.00 - H.L. separation $15.00 - mag. separation $ 3.00 Total $23.00	ICP - Chemex labs. - combined multi-acid digestion - ICP and Li-metaborate fusion - ICP - also re-dilute for high values $25.00
Balsam fir	5-10	- drying and removing needles $ 5.00 - ashing (24 hrs) $10.00 Total $15.00	ICP - ACME Analytical-Aqua Regia $4.50
Humus (-80)	5-10	- drying and sieving $ 2.00	ICP - Bondar Clegg - Aqua Regia $8.00

10 RECOMMENDATIONS FOR FUTURE WORK

A number of recommendations can be made regarding the future exploration for Canfield Creek-type (i.e. Naciemento) Cu±Ag±Zn deposits in the Cumberland Basin of north-central Nova Scotia, based upon the results of this study. The following is a list of sequential steps that we recommend:

1) Conduct detailed (e.g. 1 sample/km^2) till, Balsam fir and humus sampling of the study area to supplement the results of this study thus confirming and further defining the presence of large (5-10 km^2) negative anomalies near the Canfield Creek deposit.

2) Conduct very detailed (e.g. 1 sample/50 to 100m^2) humus sampling around trench #4 to confirm and further define the positive Ag "anomaly" for that sample.

3) Conduct additional trenching over the Canfield deposit, possibly along lines parallel to the Crowley Road, to confirm and further define the shape and lateral extent of the positive Cu-enriched zone in the Eatonville till sheet.

4) If the outcome of steps 1 to 3 confirm the findings of this preliminary study, the same procedures should then be applied to other sandstone-hosted Cu-Ag deposits in the Cumberland Basin. This step will determine if the geochemical signature of the Canfield Creek deposit is typical of this style of mineralization.

If the results of this study are reproducible at both the Canfield Creek and other deposits then a composite exploration program can be undertaken in the Cumberland Basin. This program would include:

1) Grid sampling of Balsam fir and humus over the basin using a sample density of approximately 1 sample per 2 to 5km^2 to locate negative anomalies (Cu, Pb and Zn). Till samples should also be collected at each site. The till clasts should be removed and examined to determine the proportion of red and grey clasts. The -230 mesh fraction from the till samples should also be analysed because of the potential for positive Cu enrichment (anomalies?).

2) Target areas with low levels of Cu, Pb and Zn in humus and Balsam fir, similar to the concentrations in this study, should then be sampled in detail to outline the extent of these negative anomalies.

3) Trenching near positive Ag anomalies in humus, if present, should then be conducted to define positive Cu-enriched zones that may be traced back to subcroppings of potentially mineralized strata.

It should be stressed that these recommendations are made with some trepidation considering the limited extent of the geochemical enrichment and depletion displayed by the Canfield Creek deposit. Clearly the results of this study must be reproducible at more than one Cu-Ag deposit before the above exploration strategy should be implemented. In

summary, solution-front Cu-Ag deposits of the Cumberland Basin continue to be extremely challenging targets for the exploration geochemist. The techniques that were applied in this study were conventional in terms of sample collection, sample preparation and analytical procedures. Perhaps the geochemical detection of this type of deposit will, by necessity, depend upon more unorthodox geochemical approaches.

11 ACKNOWLEDGEMENTS

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13 APPENDIX A

DATA TABLES

Table 1 Percentage of clast lithologies from regional and trench surveys.

TRENCH	DEPTH m.	RED #	RED %	GREY #	GREY %	FOREIGN #	FOREIGN %
1	2.5	52	78	12	18	3	4
	3.5	76	78	16	16	6	6
	4.2	77	73	26	25	2	2
	5.2	65	68	28	29	2	2
	5.7	78	76	17	17	8	8
2	2.0	48	67	18	25	6	8
	3.0	52	67	19	24	7	9
3	1.0	69	95	3	4	1	1
	1.0	0	0	0	0	2	100
	2.0	57	79	15	21	0	0
	2.9	69	77	21	23	0	0
	4.0	49	57	34	40	3	3
	4.4	34	55	27	44	1	2
4	2.0	58	89	4	6	3	5
	3.5	46	79	12	21	0	0
	4.6	77	82	15	16	2	2
	5.0	78	77	19	19	4	4
5	2.0	78	83	9	10	7	7
	3.5	58	95	0	0	3	5
	4.3	0	0	0	0	1	100
	4.8	0	0	0	0	1	100
6	1.9	37	73	14	27	0	0
8	1.7	95	89	9	8	3	3
	3.0	0	0	15	17	71	83
	4.0	68	85	8	10	4	5
9	1.0	41	69	11	19	7	12
10	2.0	89	90	9	9	1	1

REGIONAL SAMPLE #	RED #	RED %	GREY #	GREY %	FOREIGN #	FOREIGN %
CC-90-001	170	91	12	6	4	2
CC-90-002	100	100	0	0	0	0
CC-90-004	118	73	0	0	44	27
CC-90-005	5	100	0	0	0	0
CC-90-006	88	67	32	24	11	8
CC-90-007	98	72	25	18	13	10
CC-90-008	215	97	7	3	0	0
CC-90-009	66	52	34	27	27	21
CC-90-010	96	91	9	9	0	0
CC-90-011	70	85	12	15	0	0
CC-90-012	101	96	4	4	0	0
CC-90-013	124	96	5	4	0	0
CC-90-014	55	98	1	2	0	0
CC-90-015	39	74	10	19	4	8
CC-90-016	93	80	18	16	5	4
CC-90-017	60	78	12	16	5	6
CC-90-018	67	87	9	12	1	1
CC-90-019	169	87	23	12	2	1
CC-90-020	102	89	10	9	3	3

CANFIELDS CREEK REGIONAL SURVEY 1990 SILT AND CLAY

FIELD #		CC-90 1	CC-90 2	CC-90 4	CC-90 5	CC-90 6	CC-90 7	CC-90 8	CC-90 9	CC-90 10	CC-90 11 avg	CC-90 12	CC-90 13	CC-90 14 avg	CC-90 15	CC-90 16	CC-90 17	CC-90 18
Al	%	0.59	0.81	0.67	0.83	0.71	0.58	0.79	0.74	0.50	0.70	0.92	0.91	1.06	0.54	0.63	0.83	0.63
Fe Tot	%	1.71	2.68	1.98	2.39	2.04	1.91	2.28	2.33	1.59	2.05	2.63	2.62	3.29	1.58	2.01	2.57	1.91
Mn	%	0.05	0.13	0.03	0.03	0.06	0.03	0.07	0.03	0.04	0.05	0.05	0.06	0.07	0.07	0.04	0.03	0.05
Mg	%	0.29	0.37	0.37	0.38	0.44	0.32	0.50	0.41	0.31	0.37	0.49	0.50	0.58	0.32	0.36	0.47	0.38
Ca	%	0.02	0.08	0.05	0.05	0.19	0.04	0.22	0.05	0.15	0.07	0.03	0.04	0.05	0.18	0.08	0.04	0.11
K	%	0.03	0.03	0.04	0.08	0.06	0.04	0.10	0.08	0.04	0.04	0.05	0.06	0.05	0.04	0.04	0.05	0.05
Li	ppm	14	20	17	19	20	14	21	21	15	17	22	23	31	15	18	24	20
Sc	ppm	20	25	20	30	34	44	34	32	24	25	27	25	36	23	22	24	24
V	ppm	13	17	17	19	21	15	22	17	16	16	19	21	17	21	13	16	14
Cr	ppm	13	19	15	18	16	15	19	17	13	16	19	20	23	13	14	18	15
Co	ppm	7	11	7	11	9	7	12	9	7	8	10	10	15	7	9	9	8
Ni	ppm	14	21	16	22	18	15	23	18	15	17	21	21	27	15	17	21	17
Cu	ppm	11	9	12	7	10	10	11	8	9	11	10	10	25	13	11	12	7
Zn	ppm	37	52	48	56	44	36	67	47	39	43	52	55	80	36	48	52	44
As	ppm	2.5	2.5	2.5	2.5	8.0	2.5	2.5	2.5	2.5	6.5	2.5	2.5	6.5	2.5	2.5	2.5	2.5
Sr	ppm	2	3	2	3	6	2	7	3	4	3	2	3	3	5	3	3	4
Y	ppm	6	9	4	4	11	5	9	6	8	9	5	5	9	11	8	6	8
Zr	ppm	6.0	6.0	0.5	6.0	7.0	6.0	8.0	7.0	6.0	7.0	5.0	7.0	3.5	5.0	5.0	8.0	6.0
Ba	ppm	29	82	40	33	128	25	128	29	87	55	40	57	66	196	78	56	188
La	ppm	13	15	10	11	15	11	12	12	12	14	11	11	20	13	12	11	11
Ta	ppm	5	5	12	5	5	5	5	5	5	10	18	5	24	5	5	10	5
Pb	ppm	11	11	11	15	11	11	18	13	12	13	14	12	16	11	12	11	13

Table 2a. Analytical data for the -230 mesh fraction of till samples.

CANFIELDS CREEK REGIONAL SURVEY 1990 SILT AND CLAY

FIELD #		CC-90 19	CC-90 20
Al	%	0.64	0.59
Fe Tot	%	1.95	1.82
Mn	%	0.05	0.04
Mg	%	0.40	0.36
Ca	%	0.60	0.12
K	%	0.07	0.04
Li	ppm	21	18
Sc	ppm	34	25
V	ppm	15	13
Cr	ppm	14	13
Co	ppm	10	8
Ni	ppm	19	16
Cu	ppm	8	6
Zn	ppm	49	45
As	ppm	2.5	2.5
Sr	ppm	10	4
Y	ppm	7	8
Zr	ppm	6.0	5.0
Ba	ppm	104	87
La	ppm	9	11
Ta	ppm	18	27
Pb	ppm	23	11

Table 2a. Analytical data for the -230 mesh fraction of till samples.

CANFEILDS CREEK TRENCH SURVEY 1990 SILT AND CLAY

TRENCH #		1	1	1	1	1	2	2	3	3	3	3	3	4	4	4	4	5	5	5	5
DEPTH m.		2.5	3.5	4.2	5.2	5.7	2.0	3.0	1.0	2.0	2.9	4.0	4.4	2.0	3.5	4.6	5.0	2.0	3.5	4.3	4.9
Al	%	0.62	0.73	0.94	0.67	0.53	0.76	0.93	0.75	0.78	0.65	0.65	0.66	0.71	0.82	0.72	0.62	0.94	0.78	0.74	0.74
Fe T.	%	1.84	1.96	2.91	2.00	1.61	2.29	1.86	2.21	2.21	1.90	1.79	1.99	2.27	2.32	1.90	1.78	2.66	2.30	2.00	2.40
Mn	%	0.07	0.06	0.04	0.06	0.05	0.06	0.03	0.07	0.05	0.05	0.06	0.06	0.08	0.05	0.05	0.06	0.06	0.04	0.04	0.04
Mg	%	0.40	0.45	0.56	0.47	0.38	0.47	0.35	0.46	0.51	0.40	0.43	0.47	0.46	0.55	0.45	0.44	0.55	0.48	0.44	0.47
Ca	%	0.39	0.76	0.19	0.74	0.77	0.58	0.36	0.19	0.49	0.44	0.77	0.72	0.19	0.44	0.59	0.81	0.35	0.19	0.35	0.15
K	%	0.07	0.09	0.09	0.08	0.06	0.09	0.13	0.06	0.07	0.05	0.08	0.07	0.06	0.07	0.08	0.08	0.10	0.07	0.07	0.06
Li	ppm	17	19	29	17	15	20	12	22	24	20	19	16	19	22	22	17	27	26	24	24
Sc	ppm	33	42	38	44	46	42	41	29	42	40	34	70	60	68	31	63	37	27	38	33
V	ppm	19	22	15	20	19	20	24	14	16	13	18	19	14	14	15	18	19	11	14	12
Cr	ppm	15	16	21	15	12	17	26	16	16	14	14	16	17	17	15	14	20	17	16	16
Co	ppm	11	10	13	10	9	12	7	11	11	9	10	10	10	12	10	9	13	12	9	12
Ni	ppm	21	21	27	20	16	22	20	22	22	19	19	19	21	22	20	17	26	24	20	23
Cu	ppm	16	19	7	10	8	13	22	13	11	12	10	11	10	10	11	9	10	6	6	8
Zn	ppm	54	48	83	49	39	58	60	61	60	53	46	50	64	70	66	43	70	67	51	71
As	ppm	2.5	2.5	9.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	6.0	10.0	2.5	6.0	2.5	7.0	2.5
Sr	ppm	8	11	7	14	13	9	19	6	9	7	12	11	5	8	10	12	8	6	8	6
Y	ppm	9	8	6	8	9	8	13	7	8	6	8	7	7	6	6	9	7	6	7	6
Zr	ppm	6	7	11	6	5	8	13	6	5	5	6	6	6	5	6	6	9	9	6	10
Ba	ppm	106	216	60	214	238	117	87	86	70	65	223	206	101	116	166	254	144	64	69	47
La	ppm	11	11	11	10	9	11	39	10	10	10	10	9	10	9	10	10	11	9	11	10
Ta	ppm	15	5	5	5	22	24	5	20	18	14	5	5	11	10	5	5	5	11	5	14
Pb	ppm	15	14	23	12	10	16	6	16	12	12	12	9	16	15	12	10	20	14	15	17

Table 2a. Analytical data for the -230 mesh fraction of till samples.

CANFEILDS CREEK TRENCH SURVEY 1990 SILT AND CLAY

TRENCH #		8	8	8	6	6	6	9	10	10	10
DEPTH m.		1.7	3.0	4.0	2.0	4.0	5.0	1.0	2.0	3.6	4.8
Al	%	1.29	0.77	0.63	1.10	1.00	1.04	0.64	0.82	1.33	1.17
Fe T.	%	3.84	2.12	1.91	3.49	2.80	2.87	2.01	2.31	3.93	3.65
Mn	%	0.03	0.06	0.05	0.06	0.03	0.03	0.07	0.06	0.03	0.04
Mg	%	0.72	0.49	0.40	0.66	0.63	0.64	0.44	0.54	0.74	0.76
Ca	%	0.28	0.65	0.64	0.14	0.12	0.12	0.64	0.62	0.29	0.32
K	%	0.17	0.09	0.07	0.09	0.09	0.10	0.07	0.09	0.17	0.11
Li	ppm	39	26	21	34	30	32	15	24	40	36
Sc	ppm	45	39	37	37	31	33	68	42	44	60
V	ppm	27	16	15	16	13	14	20	18	27	15
Cr	ppm	30	17	14	42	20	21	15	17	31	26
Co	ppm	17	11	10	14	13	13	11	11	17	15
Ni	ppm	42	22	19	42	27	28	20	23	43	34
Cu	ppm	7	8	8	7	12	30	9	16	7	7
Zn	ppm	84	58	48	85	87	94	48	64	84	75
As	ppm	8.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	7.0	2.5
Sr	ppm	23	11	11	7	6	6	8	11	24	12
Y	ppm	10	7	6	7	7	7	8	8	10	6
Zr	ppm	8	6	6	9	7	7	6	6	8	8
Ba	ppm	90	112	119	92	49	69	95	134	93	74
La	ppm	8	9	10	12	14	16	10	11	8	9
Ta	ppm	12	5	10	20	22	2	5	15	10	10
Pb	ppm	15	18	24	19	45	42	12	12	15	13

Table 2a. Analytical data for the -230 mesh fraction of till samples.

CANFIELDS CREEK SURVEY -230 MESH FRACTION STANDARDS

		STD1	STD	STD1	STD2	STD2	STD2	STD-91 H	STD-91 H	STD-91 H	STD-91 H	STD-91 L	STD-91 L	STD-91 L	STD-91 L
Al	%	0.57	0.65	0.59	0.82	0.70	0.83	1.16	1.22	1.23	1.30	0.87	0.89	1.05	1.06
Fe Tot	%	1.80	1.90	1.84	1.79	1.99	1.81	2.91	2.97	2.95	3.19	2.57	2.59	2.83	2.88
Mn	%	0.02	0.02	0.02	0.03	0.06	0.03	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11
Mg	%	0.33	0.36	0.36	0.32	0.45	0.33	0.40	0.42	0.41	0.45	0.38	0.38	0.42	0.44
Ca	%	0.73	0.82	0.72	0.32	0.76	0.33	0.50	0.53	0.53	0.58	0.19	0.19	0.22	0.23
K	%	0.12	0.15	0.12	0.11	0.09	0.11	0.09	0.10	0.10	0.11	0.06	0.06	0.07	0.08
Li	ppm	7	9	7	11	19	11	23	23	24	25	19	19	23	25
Sc	ppm	48	37	75	36	46	40	46	42	37	47	34	38	29	29
V	ppm	24	25	24	23	20	23	21	21	21	22	20	20	23	23
Cr	ppm	20	23	22	24	16	25	16	16	16	18	15	15	18	18
Co	ppm	5	5	5	6	10	6	11	11	11	11	11	11	12	12
Ni	ppm	17	18	16	19	20	20	18	19	19	20	17	18	19	20
Cu	ppm	15	17	15	21	10	21	1815	1843	1841	2127	14	14	15	16
Zn	ppm	52	54	54	60	47	59	11723	11875	11819	13134	69	62	66	68
As	ppm	-5	-5	7	-5	-5	6	688	687	684	757	15	19	15	10
Sr	ppm	24	25	21	19	12	19	15	15	16	15	17	19	20	20
Y	ppm	9	10	7	12	9	13	14	14	15	15	5	6	7	6
Zr	ppm	13	14	13	12	7	11	12	14	14	15	-5	-5	-5	-5
Ba	ppm	57	65	54	79	240	80	135	156	153	151	412	486	494	579
La	ppm	30	36	29	34	11	35	6	7	7	7	8	8	10	10
Ta	ppm	12	-10	11	23	-10	25	20	21	11	16	12	14	-5	-10
Pb	ppm	6	6	5	5	15	7	1562	1562	1634	1818	22	23	26	26

Table 2b

Analytical data for standards used in the analysis of -230 mesh fraction of till samples.

CANFIELDS CREEK SURVEY -230 MESH FRACTION ANALYTICAL SPLITS

		SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT
Al	%	0.65	0.66	0.71	0.60	1.04	1.06	1.16	1.20	0.93	0.67	1.17	1.02	1.00	1.07
Fe Tot	%	1.79	1.78	2.04	1.87	3.25	3.15	3.72	3.84	1.86	2.01	3.65	3.33	2.80	2.85
Mn	%	0.06	0.06	0.06	0.05	0.06	0.06	0.05	0.05	0.03	0.06	0.04	0.04	0.03	0.04
Mg	%	0.43	0.41	0.44	0.42	0.63	0.65	0.68	0.72	0.35	0.45	0.76	0.66	0.63	0.65
Ca	%	0.77	0.76	0.19	0.17	0.14	0.15	0.14	0.15	0.36	0.19	0.32	0.29	0.12	0.12
K	%	0.08	0.08	0.06	0.05	0.08	0.08	0.09	0.09	0.13	0.08	0.11	0.09	0.09	0.10
Li	ppm	19	20	20	15	33	34	35	37	12	17	36	33	30	33
Sc	ppm	34	31	34	59	35	34	38	37	41	34	60	42	31	23
V	ppm	18	18	21	20	15	15	17	18	24	20	15	15	13	14
Cr	ppm	14	14	16	15	23	22	60	65	26	16	26	23	20	21
Co	ppm	10	10	9	8	13	13	15	14	7	11	15	15	13	13
Ni	ppm	19	20	18	17	28	29	55	57	20	22	34	32	27	29
Cu	ppm	10	10	10	9	6	8	8	8	22	10	7	7	12	32
Zn	ppm	46	45	44	42	77	87	92	92	60	64	75	71	87	223
As	ppm	-5	-5	8	5	-5	6	-5	7	-5	9	-5	7	-5	6
Sr	ppm	12	13	6	5	7	7	7	7	19	6	12	13	6	6
Y	ppm	8	9	11	9	6	7	7	8	13	8	6	6	7	6
Zr	ppm	6	6	7	6	8	8	10	11	13	6	8	7	7	7
Ba	ppm	223	238	128	108	89	94	94	98	87	112	74	68	49	54
La	ppm	10	11	15	12	11	11	13	14	39	10	9	7	14	13
Ta	ppm	-10	-10	-10	-5	26	25	13	24	-10	11	10	16	22	17
Pb	ppm	12	12	11	9	18	16	19	19	6	16	13	11	45	64

Table 2c

Analytical data for sample splits used in the analysis of the -230 mesh fraction of till samples.

CANFIELDS CREEK SURVEY -230 MESH FRACTION FIELD DUPLICATES

		SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	TRIPLICATE
Al	%	0.54	0.86	0.71	0.69	0.82	1.17	1.13	1.06	0.94
Fe Tot	%	1.76	2.34	2.19	2.20	2.31	3.65	3.00	2.78	2.83
Mn	%	0.04	0.05	0.04	0.06	0.06	0.04	0.04	0.03	0.03
Mg	%	0.32	0.42	0.39	0.38	0.54	0.76	0.70	0.63	0.58
Ca	%	0.08	0.06	0.03	0.04	0.62	0.32	0.12	0.12	0.12
K	%	0.04	0.04	0.03	0.04	0.09	0.11	0.12	0.10	0.09
Li	ppm	14	20	20	21	24	36	35	32	29
Sc	ppm	21	29	21	29	42	60	36	34	30
V	ppm	15	17	11	12	18	15	15	14	14
Cr	ppm	14	18	15	15	17	26	23	21	20
Co	ppm	7	8	10	10	11	15	14	13	12
Ni	ppm	15	19	18	18	23	34	30	28	27
Cu	ppm	9	12	17	16	16	7	32	17	40
Zn	ppm	37	48	52	55	64	75	96	83	102
As	ppm	6	7	-5	8	-5	-5	-5	-5	8
Sr	ppm	3	2	2	2	11	12	7	6	6
Y	ppm	8	9	5	7	8	6	7	7	7
Zr	ppm	6	8	-5	6	6	8	7	7	8
Ba	ppm	55	54	36	59	134	74	84	67	57
La	ppm	12	16	13	13	11	9	16	16	15
Ta	ppm	14	-5	21	-5	15	10	-5	-5	16
Pb	ppm	10	15	10	12	12	13	40	49	37

Table 2d.
Analytical data for field duplicates used in the analysis of the -230 mesh fraction of till samples.

CANFIELDS CREEK REGIONAL SURVEY 1990 HEAVY MINERALS

SAMPLE NUMBER		CC-90 16	CC-90 17	CC-90 18	CC-90 19	CC-90 20
Ag	ppm	1.5	1.0	.25	.25	.25
Al	%	4.23	1.71	3.89	4.09	3.76
Ba	ppm	290	160	300	300	280
Ca	%	1.09	0.11	1.51	1.43	1.79
Cd	ppm	1.5	1.0	0.5	1.5	1.0
Co	ppm	7	18	9	11	13
Cr	ppm	159	197	176	131	150
Cu	ppm	0.5	0.5	0.5	0.5	0.5
Fe	%	23.82	12.46	22.18	21.83	22.55
K	%	0.67	0.57	0.58	0.65	0.58
Mg	%	0.53	0.22	0.55	0.61	0.55
Mn	ppm	8910	4280	9505	9020	9310
Mo	ppm	1	1	1	1	1
Na	%	0.31	0.09	0.34	0.38	0.35
Ni	ppm	18	22	22	23	20
P	ppm	3400	1900	5400	4700	6110
Pb	ppm	156	352	130	134	126
Sr	ppm	160	143	227	224	224
Ti	%	12.60	5.47	14.42	14.18	14.71
V	ppm	394	581	417	341	405
W	ppm	30	40	30	10	30
Zn	ppm	104	146	106	116	100
Zr	ppm	6400	3180	5600	5900	5960

Table 3a. Unweighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

CANFIELDS CREEK TRENCH SURVEY 1990 HEAVY MINERALS

TRENCH #		1	1	1	1	1	2	2	3	3	3	3	3	4	4	4	avg.4	5
DEPTH m.		2.5	3.5	4.2	5.2	5.7	2.0	3.0	1.0	2.0	2.9	4.0	4.4	2.0	3.5	4.6	5.0	2.0
Ag	ppm	.25	.25	.25	.25	1.5	.25	.25	1.0	1.0	.25	.25	.25	2.5	.25	.25	.25	.25
Al	%	3.76	3.63	3.62	3.68	3.59	3.87	3.66	4.34	4.30	3.79	3.40	3.82	3.80	3.99	3.79	3.42	3.93
Ba	ppm	790	10480	12370	13040	13320	950	440	390	420	1310	12860	13170	390	8270	9480	13310	400
Ca	%	1.92	1.87	1.66	1.70	1.77	1.78	1.76	1.42	1.54	1.26	1.77	1.94	1.29	1.21	1.45	1.73	1.96
Cd	ppm	0.3	1.0	1.0	0.3	0.5	1.0	2.0	0.3	1.0	1.0	0.3	1.5	0.5	1.0	0.5	0.3	1.5
Co	ppm	15	13	5	8	11	14	12	15	17	15	10	14	10	16	20	19	8
Cr	ppm	187	172	153	196	164	196	214	144	141	142	191	170	141	131	171	181	157
Cu	ppm	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	9	0.5
Fe	%	25.66	23.95	23.08	26.12	22.97	26.04	24.84	23.88	24.13	24.29	22.55	23.60	24.27	24.44	23.66	23.09	25.49
K	%	0.61	0.59	0.60	0.66	0.61	0.65	0.59	0.81	0.78	0.67	0.54	0.66	0.66	0.74	0.67	0.54	0.61
Mg	%	0.63	0.62	0.59	0.63	0.64	0.62	0.60	0.57	0.62	0.49	0.58	0.66	0.46	0.51	0.56	0.56	0.64
Mn	ppm	6520	5955	5770	5380	5170	6450	7280	8615	9325	9510	6240	5840	10460	8520	7770	6485	6180
Mo	ppm	3	1	1	1	1	1	1	1	2	1	2	1	1	2	1	1	1
Na	%	0.30	0.29	0.28	0.30	0.29	0.29	0.26	0.35	0.37	0.32	0.27	0.32	0.31	0.33	0.32	0.26	0.27
Ni	ppm	26	26	19	23	25	26	30	23	29	22	20	24	22	24	21	24	25
P	ppm	5330	3580	4670	4550	3380	4430	4440	5280	5200	3270	4370	4670	4340	4250	3940	4180	5400
Pb	ppm	146	130	134	144	148	154	170	178	190	178	146	164	190	220	168	156	146
Sr	ppm	166	199	193	232	223	150	146	182	175	149	222	220	163	185	207	241	159
Ti	%	9.11	7.38	7.46	8.84	7.16	9.22	8.98	10.71	11.63	11.06	8.59	7.24	12.87	11.72	10.73	8.37	9.20
V	ppm	614	581	597	645	565	610	612	362	351	346	609	581	371	344	469	580	557
W	ppm	50	20	40	40	30	20	30	40	20	10	40	20	40	20	40	40	30
Zn	ppm	118	134	106	124	110	132	138	114	112	114	122	122	100	138	124	118	114
Zr	ppm	4570	3160	1950	2700	1950	3000	4370	4500	4660	6440	3650	2930	6880	4500	5300	3560	3900

Table 3a. Unweighted analyical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

CANFIELDS CREEK TRENCH SURVEY 1990 HEAVY MINERALS.

TRENCH #		5	5	5	6	6	avg.6	8	8	8	9	10	10
DEPTH m.		3.5	4.3	4.9	2.0	4.0	5.0	1.7	3.0	4.0	1.0	2.0	4.8
Ag	ppm	0.5	.25	.25	.25	1.0	0.6	.25	.25	0.5	.25	.25	.25
Al	%	4.28	3.64	4.97	4.69	4.62	4.71	4.11	4.30	3.92	4.09	3.85	8.75
Ba	ppm	610	710	520	360	530	1927	1810	9580	9900	380	5170	770
Ca	%	1.13	0.83	1.07	2.56	0.64	0.74	1.74	1.65	1.71	2.21	1.75	0.29
Cd	ppm	0.5	0.3	1.0	1.0	1.0	0.6	1.0	0.5	0.3	0.3	0.5	1.0
Co	ppm	18	23	13	17	11	19	12	20	20	14	18	9
Cr	ppm	178	220	159	238	140	135	149	140	139	208	171	139
Cu	ppm	0.5	0.5	0.5	0.5	0.5	381	0.5	0.5	0.5	0.5	0.5	0.5
Fe	%	27.63	17.29	27.49	10.96	27.29	22.81	25.26	24.36	25.33	26.15	23.71	25.80
K	%	0.82	0.56	1.01	0.67	1.03	0.96	0.72	0.80	0.68	0.65	0.70	2.28
Mg	%	0.52	0.40	0.60	0.68	0.55	0.65	0.55	0.59	0.54	0.69	0.62	0.75
Mn	ppm	5630	6955	4895	8650	5585	6153	8955	8310	8820	6420	7255	660
Mo	ppm	3	2	1	1	4	3	1	2	3	1	2	3
Na	%	0.30	0.12	0.34	0.37	0.39	0.40	0.34	0.36	0.32	0.31	0.34	0.42
Ni	ppm	21	23	30	24	30	31	23	29	25	26	26	28
P	ppm	3010	4380	3560	4480	2150	2963	7620	6390	5870	5640	5030	870
Pb	ppm	256	298	294	188	674	535	220	234	290	152	148	148
Sr	ppm	199	158	176	265	137	150	215	244	226	171	191	316
Ti	%	6.65	5.96	6.70	5.30	7.62	7.71	11.57	10.16	9.24	9.57	9.34	0.79
V	ppm	378	635	384	552	241	235	416	408	442	659	504	383
W	ppm	20	30	20	50	20	23	20	30	50	30	20	20
Zn	ppm	126	156	132	130	116	139	102	106	106	154	130	100
Zr	ppm	2770	3100	2500	1634	1950	2773	4000	4100	3450	4250	3560	248

Table 3a. Unweighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

CANFIELDS CREEK REGIONAL SURVEY 1990 WEIGHTED HEAVY MINERALS

SAMPLE NUMBER		CC-90 1	CC-90 2	CC-90 4	CC-90 5	CC-90 6	CC-90 7	CC-90 8	CC-90 9	CC-90 10	CC-90 11	CC-90 12	CC-90 13	CC-90 14	CC-90 15
Ag	ppm	0.0104	0.0037	0.0039	0.0146	0.0048	0.0143	0.0016	0.0064	0.0042	0.0196	0.0062	0.0013	0.0151	0.0096
Al	%	0.0277	0.0982	0.0141	0.0195	0.0315	0.0248	0.0299	0.0257	0.0328	0.0414	0.0284	0.0230	0.0401	0.0196
Ba	ppm	2.1592	5.8400	0.6196	1.1664	2.6761	1.3185	1.3755	1.4696	2.8484	3.5677	1.3036	1.2856	2.5908	2.8868
Ca	%	0.0029	0.0055	0.0035	0.0014	0.0176	0.0065	0.0113	0.0055	0.0130	0.0116	0.0094	0.0054	0.0029	0.0154
Cd	ppm	0.0070	0.0075	0.0012	0.0021	0.0048	0.0029	0.0020	0.0019	0.0126	0.0115	0.0031	0.0051	0.0188	0.0064
Co	ppm	0.0836	0.2096	0.0116	0.0417	0.1147	0.0344	0.0721	0.0767	0.0922	0.1266	0.0621	0.0257	0.1790	0.0513
Cr	ppm	1.2746	1.9467	0.7125	0.7373	1.7586	0.9287	1.4148	1.0799	1.6420	2.2039	0.9994	0.8794	1.3048	1.1483
Cu	ppm	0.0035	0.0075	0.0019	0.0021	0.0048	0.0029	0.0033	0.0032	0.0042	0.0058	0.0031	0.0026	0.2167	0.0032
Fe	%	0.1961	0.3468	0.0864	0.0926	0.2385	0.1421	0.1530	0.1527	0.2162	0.2848	0.1347	0.1139	0.2269	0.1370
K	%	0.0047	0.0201	0.0018	0.0034	0.0044	0.0037	0.0035	0.0038	0.0059	0.0062	0.0035	0.0029	0.0070	0.0023
Mg	%	0.0032	0.0085	0.0024	0.0020	0.0051	0.0038	0.0050	0.0042	0.0044	0.0055	0.0050	0.0035	0.0048	0.0036
Mn	ppm	51.8196	163.9698	37.2147	40.6167	80.9998	41.7039	95.8920	44.9838	58.3493	96.6447	53.1672	72.5864	89.5019	47.1823
Mo	ppm	0.0209	0.0299	0.0039	0.0042	0.0191	0.0057	0.0066	0.0128	0.0335	0.0173	0.0062	0.0051	0.0141	0.0064
Na	%	0.0017	0.0054	0.0010	0.0012	0.0025	0.0015	0.0017	0.0015	0.0021	0.0026	0.0020	0.0015	0.0029	0.0019
Ni	ppm	0.1254	0.4043	0.0813	0.0875	0.1816	0.1605	0.1572	0.1342	0.1843	0.2417	0.1179	0.0874	0.2308	0.1155
P	ppm	8.4973	28.7509	7.9386	9.0815	38.0389	5.1593	11.2660	5.1757	31.4994	18.9319	9.8699	9.0508	20.7268	35.0259
Pb	ppm	1.3373	1.5573	0.4957	0.7415	1.2425	0.8484	0.8515	0.8690	1.5415	1.8874	0.9560	0.6788	1.2342	0.7313
Sr	ppm	0.8776	2.6505	0.5344	0.6707	1.2807	0.9745	1.4607	0.8946	1.4493	1.4674	1.1918	0.8022	1.7052	1.0456
Ti	%	0.0577	0.1107	0.0598	0.0529	0.0905	0.0621	0.0899	0.0548	0.0742	0.0954	0.0928	0.0712	0.1335	0.0620
V	ppm	3.1969	4.0730	1.9246	1.4497	5.6198	2.3847	2.7772	2.7987	4.4652	5.7831	2.3340	2.1136	2.5343	3.7143
W	ppm	0.1393	0.1497	0.1162	0.0833	0.2867	0.1720	0.2620	0.1917	0.2513	0.5179	0.1242	0.2057	0.1884	0.2566
Zn	ppm	0.7244	1.4675	0.4066	0.3916	0.9558	0.6306	0.9039	0.6901	0.9550	1.3005	0.6456	0.5760	0.9987	0.6287
Zr	ppm	32.8052	86.1029	43.2558	54.1556	50.9415	37.8345	67.4650	38.8496	41.8875	60.7087	51.0877	30.8550	79.0443	22.3242

Table (3b)
Weighted analytical data for non-magnetic heavy mineral separates (-60+230).

CANFIELDS CREEK REGIONAL SURVEY 1990 WEIGHTED HEAVY MINERALS

SAMPLE NUMBER		CC-90 16	CC-90 17	CC-90 18	CC-90 19	CC-90 20
Ag	ppm	0.0095	0.0015	0.0017	0.0018	0.0015
Al	%	0.0268	0.0026	0.0268	0.0299	0.0226
Ba	ppm	1.8393	0.2399	2.0670	2.1908	1.6814
Ca	%	0.0069	0.0002	0.0104	0.0104	0.0107
Cd	ppm	0.0095	0.0015	0.0034	0.0110	0.0060
Co	ppm	0.0444	0.0270	0.0620	0.0803	0.0781
Cr	ppm	1.0085	0.2954	1.2126	0.9566	0.9008
Cu	ppm	0.0032	0.0007	0.0034	0.0037	0.0030
Fe	%	0.1511	0.0187	0.1528	0.1594	0.1354
K	%	0.0042	0.0009	0.0040	0.0047	0.0035
Mg	%	0.0034	0.0003	0.0038	0.0045	0.0033
Mn	ppm	56.5117	6.4176	65.4895	65.8686	55.9066
Mo	ppm	0.0063	0.0015	0.0069	0.0073	0.0060
Na	%	0.0020	0.0001	0.0023	0.0028	0.0021
Ni	ppm	0.1142	0.0330	0.1516	0.1680	0.1201
P	ppm	21.5645	2.8489	37.2060	34.3218	36.6906
Pb	ppm	0.9894	0.5278	0.8957	0.9785	0.7566
Sr	ppm	1.0148	0.2144	1.5640	1.6358	1.3451
Ti	%	0.0799	0.0082	0.0994	0.1035	0.0883
V	ppm	2.4989	0.8712	2.8731	2.4902	2.4320
W	ppm	0.1903	0.0600	0.2067	0.0730	0.1802
Zn	ppm	0.6596	0.2189	0.7303	0.8471	0.6005
Zr	ppm	40.5920	4.7682	38.5840	43.0848	35.7898

Table (3b)
Weighted analytical data for non-magnetic heavy mineral separates (-60+230).

CANFIELDS CREEK TRENCH SURVEY 1990 WEIGHTED HEAVY MINERALS

TRENCH #		1	1	1	1	1	2	2	3	3	3	3	3
DEPTH m.		2.5	3.5	4.2	5.2	5.7	2.0	3.0	1.0	2.0	2.9	4.0	4.4
Ag	ppm	0.00181	0.00275	0.00167	0.00214	0.01204	0.00185	0.00206	0.00854	0.00747	0.00200	0.00259	0.00221
Al	%	0.02729	0.03992	0.02424	0.03149	0.02881	0.02871	0.03014	0.03706	0.03212	0.03032	0.03529	0.03383
Ba	ppm	5.73343	115.24962	82.84543	111.58811	106.88338	7.04742	3.62340	3.33060	3.13705	10.48000	133.47092	116.64091
Ca	%	0.01393	0.02056	0.01112	0.01455	0.01420	0.01320	0.01449	0.01213	0.01150	0.01008	0.01837	0.01718
Cd	ppm	0.00218	0.01100	0.00670	0.00257	0.00401	0.00742	0.01647	0.00256	0.00747	0.00800	0.00311	0.01328
Co	ppm	0.10886	0.14296	0.03349	0.06846	0.08827	0.10386	0.09882	0.12810	0.12698	0.12000	0.10379	0.12399
Cr	ppm	1.35715	1.89150	1.02468	1.67724	1.31598	1.45399	1.76229	1.22976	1.05315	1.13600	1.98234	1.50562
Cu	ppm	0.00363	0.00550	0.00335	0.00428	0.00401	0.00371	0.00412	0.00427	0.00373	0.00400	0.00519	0.00443
Fe	%	0.18623	0.26338	0.15457	0.22352	0.18432	0.19317	0.20456	0.20394	0.18023	0.19432	0.23404	0.20901
K	%	0.00443	0.00649	0.00402	0.00565	0.00489	0.00482	0.00486	0.00692	0.00583	0.00536	0.00560	0.00585
Mg	%	0.00457	0.00682	0.00395	0.00539	0.00514	0.00460	0.00494	0.00487	0.00463	0.00392	0.00602	0.00585
Mn	ppm	47.31890	65.48774	38.64334	46.03865	41.48552	47.84830	59.95080	73.57210	69.65000	76.08000	64.76350	51.72232
Mo	ppm	0.02177	0.01100	0.00670	0.00856	0.00802	0.00742	0.00824	0.00854	0.01494	0.00800	0.02076	0.00886
Na	%	0.00218	0.00319	0.00188	0.00257	0.00233	0.00215	0.00214	0.00299	0.00276	0.00256	0.00280	0.00283
Ni	ppm	0.18870	0.28592	0.12725	0.19682	0.20061	0.19288	0.24705	0.19642	0.21661	0.17600	0.20758	0.21256
P	ppm	38.68248	39.36962	31.27633	38.93603	27.12206	32.86325	36.56340	45.09120	38.83968	26.16000	45.35520	41.36014
Pb	ppm	1.05960	1.42962	0.89744	1.23226	1.18759	1.14242	1.39995	1.52012	1.41914	1.42400	1.51530	1.45248
Sr	ppm	1.20475	2.18842	1.29258	1.98531	1.78941	1.11275	1.20231	1.55428	1.30710	1.19200	2.30409	1.94844
Ti	%	0.06612	0.08116	0.04996	0.07565	0.05745	0.06840	0.07395	0.09146	0.08687	0.08848	0.08915	0.06412
V	ppm	4.45611	6.38932	3.99828	5.51950	4.53372	4.52519	5.03982	3.09148	2.62168	2.76800	6.32067	5.14566
W	ppm	0.36288	0.21994	0.26789	0.34229	0.24073	0.14837	0.24705	0.34160	0.14938	0.08000	0.41515	0.17713
Zn	ppm	0.85639	1.47361	0.70991	1.06111	0.88267	0.97922	1.13643	0.97356	0.83655	0.91200	1.26621	1.08050
Zr	ppm	33.16678	34.75084	13.05971	23.10490	15.64734	22.25503	35.98695	38.43000	34.80633	51.52000	37.88249	25.94972

Table (3b)
Weighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

CANFIELDS CREEK TRENCH SURVEY 1990 WEIGHTED HEAVY MINERALS.

TRENCH #		4	4	4	4	5	5	5	5	6	6	6
DEPTH m.		2.0	3.5	4.6	5.0	2.0	3.5	4.3	4.9	2.0	4.0	5.0
Ag	ppm	0.00130	0.00187	0.00156	0.00164	0.00233	0.00142	0.00016	0.00083	0.00054	0.00190	0.00290
Al	%	0.01981	0.02987	0.02371	0.02248	0.03664	0.01218	0.00231	0.01655	0.01006	0.00879	0.02275
Ba	ppm	2.03288	61.90095	59.29845	87.47998	3.72953	1.73574	0.45091	1.73175	0.77185	1.00824	9.30077
Ca	%	0.00672	0.00906	0.00907	0.01137	0.01827	0.00322	0.00053	0.00356	0.00549	0.00122	0.00356
Cd	ppm	0.00261	0.00749	0.00313	0.00197	0.01399	0.00142	0.00019	0.00333	0.00214	0.00190	0.00290
Co	ppm	0.05213	0.11976	0.12510	0.12488	0.07459	0.05122	0.01461	0.04329	0.03645	0.02093	0.09011
Cr	ppm	0.73496	0.98054	1.06962	1.18962	1.46384	0.50649	0.13972	0.52952	0.51028	0.26633	0.65170
Cu	ppm	0.00261	0.00374	0.00313	0.05915	0.00466	0.00142	0.00032	0.00167	0.00107	0.00095	1.83763
Fe	%	0.12651	0.18293	0.14800	0.15176	0.23766	0.07862	0.01098	0.09155	0.02350	0.05191	0.11010
K	%	0.00344	0.00554	0.00419	0.00355	0.00569	0.00233	0.00036	0.00336	0.00144	0.00196	0.00465
Mg	%	0.00240	0.00382	0.00350	0.00368	0.00597	0.00148	0.00025	0.00200	0.00146	0.00105	0.00312
Mn	ppm	54.52275	63.77220	48.60221	42.62266	57.62122	16.02001	4.41705	16.30176	18.54583	10.62457	29.70455
Mo	ppm	0.00521	0.01497	0.00626	0.00657	0.00932	0.00854	0.00127	0.00333	0.00214	0.00761	0.01609
Na	%	0.00162	0.00247	0.00200	0.00171	0.00252	0.00085	0.00008	0.00113	0.00079	0.00074	0.00193
Ni	ppm	0.11468	0.17964	0.13136	0.15774	0.23310	0.05975	0.01461	0.09991	0.05146	0.05707	0.14804
P	ppm	22.62225	31.81125	24.64513	27.47305	50.34864	8.56487	2.78169	11.85582	9.60524	4.09003	14.30517
Pb	ppm	0.99038	1.64670	1.05086	1.02531	1.36128	0.72844	0.18926	0.97910	0.40308	1.28218	2.58105
Sr	ppm	0.84964	1.38473	1.29481	1.58397	1.48249	0.56625	0.10034	0.58613	0.56817	0.26062	0.72572
Ti	%	0.06708	0.08772	0.06712	0.05501	0.08578	0.01892	0.00379	0.02231	0.01136	0.01450	0.03722
V	ppm	1.93384	2.57484	2.93365	3.81205	5.19337	1.07559	0.40328	1.27883	1.18350	0.45846	1.13605
W	ppm	0.20850	0.14970	0.25020	0.26290	0.27971	0.05691	0.01905	0.06661	0.10720	0.03805	0.11264
Zn	ppm	0.52125	1.03293	0.77563	0.77556	1.06292	0.35853	0.09907	0.43960	0.27872	0.22067	0.67262
Zr	ppm	35.86200	33.68250	33.15209	23.39810	36.36290	7.88196	1.96878	8.32572	3.50334	3.70956	13.38796

Table (3b)
Weighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

CANFIELDS CREEK TRENCH SURVEY 1990 WEIGHTED HEAVY MINERALS.

TRENCH #		8	8	8	9	10	10
DEPTH m.		1.7	3.0	4.0	1.0	2.0	4.8
Ag	ppm	0.00195	0.00249	0.00408	0.00250	0.00189	0.00609
Al	%	0.03213	0.04287	0.03196	0.04096	0.02905	0.21330
Ba	ppm	14.14968	95.50613	80.70968	3.80570	39.01114	18.77024
Ca	%	0.01360	0.01645	0.01394	0.02213	0.01320	0.00707
Cd	ppm	0.00782	0.00498	0.00245	0.00300	0.00377	0.02438
Co	ppm	0.09381	0.19939	0.16305	0.14021	0.13582	0.21939
Cr	ppm	1.16481	1.39571	1.13320	2.08312	1.29031	3.38839
Cu	ppm	0.00391	0.00498	0.00408	0.00501	0.00377	0.01219
Fe	%	0.19747	0.24285	0.20650	0.26189	0.17891	0.62892
K	%	0.00563	0.00798	0.00554	0.00651	0.00528	0.05558
Mg	%	0.00430	0.00588	0.00440	0.00691	0.00468	0.01828
Mn	ppm	70.00571	82.84509	71.90499	64.29630	54.74387	16.08877
Mo	ppm	0.00782	0.01994	0.02446	0.01002	0.01509	0.07313
Na	%	0.00266	0.00359	0.00261	0.00310	0.00257	0.01024
Ni	ppm	0.17980	0.28911	0.20381	0.26039	0.19619	0.68255
P	ppm	59.56935	63.70399	47.85513	56.48460	37.95474	21.20793
Pb	ppm	1.71985	2.33282	2.36422	1.52228	1.11676	3.60779
Sr	ppm	1.68076	2.43252	1.84246	1.71257	1.44122	7.70311
Ti	%	0.09045	0.10129	0.07533	0.09584	0.07048	0.01926
V	ppm	3.25208	4.06748	3.60340	6.59989	3.80302	9.33636
W	ppm	0.15635	0.29908	0.40762	0.30045	0.15091	0.48754
Zn	ppm	0.79739	1.05675	0.86416	1.54231	0.98094	2.43769
Zr	ppm	31.27000	40.87423	28.12610	42.56375	26.86260	6.04548

Table (3b)
Weighted analytical data for non-magnetic heavy mineral separates (-60+230 mesh fraction).

CANFIELDS CREEK SURVEY - HEAVY MINERAL STANDARDS

		STD-91-H	STD-91-H	STD-91-H	STD-91-H	STD-91-L	STD-91-L	STD-91-L	STD-91-L
Ag	ppm	3.0	3.0	4.0	2.5	0.3	0.3	0.3	0.3
Al	%	5.87	5.93	5.88	5.92	6.09	6.20	6.14	6.22
Ba	ppm	1170	1310	1210	1280	1230	1270	1300	1350
Ca	%	0.77	0.79	0.82	0.83	0.53	0.55	0.56	0.57
Cd	ppm	48.5	49.0	47.5	46.0	0.3	1.0	0.5	0.5
Co	ppm	12	15	10	7	16	9	12	13
Cr	ppm	54	47	43	41	47	60	41	52
Cu	ppm	1805	1850	1890	1755	13	17	9	15
Fe	%	3.72	3.80	3.77	3.83	3.51	3.58	3.60	3.62
K	%	1.39	1.36	1.34	1.31	1.46	1.48	1.42	1.43
Mg	%	0.67	0.68	0.70	0.70	0.76	0.78	0.79	0.79
Mn	ppm	1455	1475	1455	1480	1565	1600	1580	1570
Mo	ppm	10	11	10	11	1	1	1	1
Na	%	0.80	0.82	0.81	0.81	0.91	0.90	0.90	0.92
Ni	ppm	17	18	20	22	21	25	19	24
P	ppm	630	770	630	670	540	600	630	390
Pb	ppm	1610	1620	1580	1580	36	48	42	44
Sr	ppm	88	89	89	87	103	101	101	102
Ti	%	0.67	0.70	0.65	0.66	0.70	0.76	0.72	0.73
V	ppm	69	66	67	65	72	76	72	75
W	ppm	40	40	40	40	5	5	10	5
Zn	ppm	15630	16610	17180	16770	84	84	84	82
Zr	ppm	850	815	830	880	880	890	890	915

Table 3c.
Unweighted analytical data for standards used in heavy mineral samples.

CANFIELDS CREEK SURVEY - HEAVY MINERAL SAMPLE SPLITS

		SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT
Ag	ppm	0.3	0.3	0.3	0.3	0.5	0.3	1.0	1.0
Al	%	6.56	6.93	4.11	4.07	3.91	4.11	4.34	4.47
Ba	ppm	390	480	1810	1730	340	380	390	400
Be	ppm	0.3	2.0	0.3	0.3	0.3	0.3	0.3	0.3
Bi	ppm	1	1	1	1	1	1	1	1
Ca	%	0.37	0.28	1.74	1.70	1.55	1.70	1.42	1.41
Cd	ppm	0.5	0.3	1.0	0.5	1.5	1.5	0.3	1.0
Co	ppm	14	12	12	19	11	10	15	12
Cr	ppm	130	119	149	183	196	185	144	136
Cu	ppm	1	1	1	1	1	1	1	1
Fe	%	23.16	22.63	25.26	24.78	25.81	26.39	23.88	24.23
K	%	1.34	1.43	0.72	0.73	0.70	0.69	0.81	0.88
Mg	%	0.57	0.59	0.55	0.54	0.52	0.53	0.57	0.59
Mn	ppm	10950	7305	8955	8995	6965	7030	8615	8065
Mo	ppm	2	1	1	2	4	3	1	2
Na	%	0.36	0.38	0.34	0.33	0.25	0.28	0.35	0.38
Ni	ppm	27	25	23	31	22	20	23	25
P	ppm	1920	1480	7620	7190	3760	4820	5280	4060
Pb	ppm	104	92	220	236	184	178	178	196
Sr	ppm	177	179	215	223	173	167	182	181
Ti	%	7.39	5.64	11.57	11.13	8.86	8.77	10.71	10.20
V	ppm	272	259	416	469	533	548	362	384
W	ppm	10	20	20	30	30	20	40	20
Zn	ppm	98	94	102	116	114	112	114	114
Zr	ppm	5750	2880	4000	3940	5000	4530	4500	3800

Table 3d.
Unweighted analytical data for analytical splits in heavy mineral samples.

CANFIELDS CREEK REGIONAL SURVEY - WEIGHTED SAMPLE SPLITS

		SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT
Ag	ppm	0.0450	0.0450	0.0023	0.0023	0.0021	0.0013	0.0064	0.0064
Al	%	0.9840	1.0395	0.0321	0.0317	0.0164	0.0173	0.0278	0.0286
Ba	ppm	58.5000	72.0000	14.1180	13.4940	1.4280	1.5960	2.4960	2.5600
Be	ppm	0.0450	0.3000	0.0023	0.0023	0.0013	0.0013	0.0019	0.0019
Bi	ppm	0.1500	0.1500	0.0078	0.0078	0.0042	0.0042	0.0064	0.0064
Ca	%	0.0555	0.0420	0.0136	0.0133	0.0065	0.0071	0.0091	0.0090
Cd	ppm	0.0750	0.0450	0.0078	0.0039	0.0063	0.0063	0.0019	0.0064
Co	ppm	2.1000	1.8000	0.0936	0.1482	0.0462	0.0420	0.0960	0.0768
Cr	ppm	19.5000	17.8500	1.1622	1.4274	0.8232	0.7770	0.9216	0.8704
Cu	ppm	0.1500	0.1500	0.0078	0.0078	0.0042	0.0042	0.0064	0.0064
Fe	%	3.4740	3.3945	0.1970	0.1933	0.1084	0.1108	0.1528	0.1551
K	%	0.2010	0.2145	0.0056	0.0057	0.0029	0.0029	0.0052	0.0056
Mg	%	0.0855	0.0885	0.0043	0.0042	0.0022	0.0022	0.0036	0.0038
Mn	ppm	1642.5000	1095.7500	69.8490	70.1610	29.2530	29.5260	55.1360	51.6160
Mo	ppm	0.3000	0.1500	0.0078	0.0156	0.0168	0.0126	0.0064	0.0128
Na	%	0.0540	0.0570	0.0027	0.0026	0.0011	0.0012	0.0022	0.0024
Ni	ppm	4.0500	3.7500	0.1794	0.2418	0.0924	0.0840	0.1472	0.1600
P	ppm	288.0000	222.0000	59.4360	56.0820	15.7920	20.2440	33.7920	25.9840
Pb	ppm	15.6000	13.8000	1.7160	1.8408	0.7728	0.7476	1.1392	1.2544
Sr	ppm	26.5500	26.8500	1.6770	1.7394	0.7266	0.7014	1.1648	1.1584
Ti	%	1.1085	0.8460	0.0902	0.0868	0.0372	0.0368	0.0685	0.0653
V	ppm	40.8000	38.8500	3.2448	3.6582	2.2386	2.3016	2.3168	2.4576
W	ppm	1.5000	3.0000	0.1560	0.2340	0.1260	0.0840	0.2560	0.1280
Zn	ppm	14.7000	14.1000	0.7956	0.9048	0.4788	0.4704	0.7296	0.7296
Zr	ppm	862.5000	432.0000	31.2000	30.7320	21.0000	19.0260	28.8000	24.3200

Table 3e.
Weighted analytical data for analytical splits used in heavy mineral samples.

CANFIELDS CREEK SURVEY - HEAVY MINERAL FIELD DUPLICATES

		SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	DUPLICATE
Ag	ppm	1.5	2.0	3.0	0.3	0.5	1.0	0.3
Al	%	3.57	3.63	3.95	4.56	4.60	4.86	4.68
Ba	ppm	330	290	300	250	3020	790	1970
Ca	%	1.17	0.85	0.36	0.26	0.68	0.73	0.80
Cd	ppm	1.0	1.0	2.0	2.0	1.0	0.5	0.3
Co	ppm	10	12	18	20	26	16	14
Cr	ppm	197	186	153	124	147	126	132
Cu	ppm	1	1	19	27	881	174	87
Fe	%	24.97	24.53	25.98	22.19	16.18	25.08	27.16
K	%	0.53	0.54	0.67	0.81	0.93	1.07	0.89
Mg	%	0.48	0.48	0.45	0.56	0.62	0.73	0.59
Mn	ppm	8285	8510	10360	8640	5610	5810	7040
Mo	ppm	2	1	2	1	3	3	4
Na	%	0.23	0.23	0.27	0.35	0.40	0.43	0.37
Ni	ppm	16	26	26	23	39	30	23
P	ppm	1320	1970	2650	1750	1780	3350	3760
Pb	ppm	164	164	140	122	592	426	586
Sr	ppm	128	127	167	195	156	141	154
Ti	%	7.81	8.77	12.10	16.23	4.64	8.95	9.54
V	ppm	451	554	302	236	258	214	234
W	ppm	40	50	30	10	30	20	20
Zn	ppm	108	118	106	106	142	154	122
Zr	ppm	4620	5930	10100	6680	2320	2400	3600

Table 3f.
Unweighted analytical data for field duplicates in heavy mineral samples.

CANFIELDS CREEK REGIONAL SURVEY FIELD DUPLICATES - WEIGHTED HEAVY MINERALS

		SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	DUPLICATE
Ag	ppm	0.0113	0.0070	0.0213	0.0007	0.0006	0.0040	0.0007
Al	%	0.0268	0.0127	0.0280	0.0100	0.0055	0.0194	0.0103
Ba	ppm	2.4757	1.0150	2.1300	0.5500	3.6240	3.1600	4.3340
Ca	%	0.0088	0.0030	0.0026	0.0006	0.0008	0.0029	0.0018
Cd	ppm	0.0075	0.0035	0.0142	0.0044	0.0012	0.0020	0.0007
Co	ppm	0.0750	0.0420	0.1278	0.0440	0.0312	0.0640	0.0308
Cr	ppm	1.4779	0.6510	1.0863	0.2728	0.1764	0.5040	0.2904
Cu	ppm	0.0075	0.0035	0.1349	0.0594	1.0572	0.6960	0.1914
Fe	%	0.1873	0.0859	0.1845	0.0488	0.0194	0.1003	0.0598
K	%	0.0040	0.0019	0.0048	0.0018	0.0011	0.0043	0.0020
Mg	%	0.0036	0.0017	0.0032	0.0012	0.0007	0.0029	0.0013
Mn	ppm	62.1541	29.7850	73.5560	19.0080	6.7320	23.2400	15.4880
Mo	ppm	0.0150	0.0035	0.0142	0.0022	0.0036	0.0120	0.0088
Na	%	0.0017	0.0008	0.0019	0.0008	0.0005	0.0017	0.0008
Ni	ppm	0.1200	0.0910	0.1846	0.0506	0.0468	0.1200	0.0506
P	ppm	9.9026	6.8950	18.8150	3.8500	2.1360	13.4000	8.2720
Pb	ppm	1.2303	0.5740	0.9940	0.2684	0.7104	1.7040	1.2892
Sr	ppm	0.9603	0.4445	1.1857	0.4290	0.1872	0.5640	0.3388
Ti	%	0.0586	0.0307	0.0859	0.0357	0.0056	0.0358	0.0210
V	ppm	3.3834	1.9390	2.1442	0.5192	0.3096	0.8560	0.5148
W	ppm	0.3001	0.1750	0.2130	0.0220	0.0360	0.0800	0.0440
Zn	ppm	0.8102	0.4130	0.7526	0.2332	0.1704	0.6160	0.2684
Zr	ppm	34.6592	20.7550	71.7100	14.6960	2.7840	9.6000	7.9200

Table 3g.
Weighted analytical data for field duplicates used in heavy mineral samples.

CANFIELDS CREEK REGIONAL SURVEY 1990 BALSAM FIR

SAMPLE NUMBER		CC-90 1	CC-90 2	CC-90 5	CC-90 6	CC-90 7	CC-90 8	CC-90 9	CC-90 10	CC-90 11	CC-90 12	CC-90 13	CC-90 14	CC-90 15	CC-90 16	CC-90 17	CC-90 18
Cu	ppm	193	140	176	161	188	152	178	203	206	195	268	137	209	135	145	247
Pb	ppm	80	70	97	47	126	83	82	69	79	72	123	23	104	43	51	71
Zn	ppm	2502	1367	1618	959	2308	2561	1489	1937	2143	1941	2722	1640	2282	1653	1476	1476
Ag	ppm	0.2	2.3	1.9	1.6	3.5	1.4	0.6	3.5	3.1	1.6	0.1	1.5	2.0	2.3	1.0	3.1
Ni	ppm	29	23	24	16	34	19	28	32	41	28	33	20	39	38	27	25
Co	ppm	3	4	3	4	5	5	6	5	4	5	2	3	7	4	4	6
Mn	ppm	27771	21951	22389	28167	48526	9947	13436	26188	41469	13352	37034	29649	29153	34327	26535	49848
Fe	%	0.50	0.77	0.38	0.50	0.28	0.29	0.39	0.21	0.37	0.29	0.28	0.22	0.51	0.40	0.51	0.29
As	ppm	2	11	25	6	7	67	6	7	14	65	13	10	99	6	2	6
U	ppm	5	5	5	5	18	5	5	5	5	5	5	5	5	7	5	5
Th	ppm	1	3	2	1	3	1	1	1	1	1	1	3	1	3	1	3
Sr	ppm	694	412	516	499	933	648	528	703	517	578	1049	545	365	444	449	944
Cd	ppm	1.4	8.6	11.7	6.8	2.0	4.6	3.8	14.2	13.9	8.9	19.5	2.6	7.0	6.3	7.8	4.8
Sb	ppm	11	13	215	18	75	685	23	19	182	697	264	67	1171	11	15	20
V	ppm	5	16	15	10	15	8	20	11	6	8	6	5	14	8	9	9
Ca	%	18.43	19.11	22.26	25.78	18.17	26.92	26.37	21.36	19.59	18.11	24.71	17.77	24.36	20.22	20.11	22.13
P	%	4.229	4.091	4.047	2.409	2.277	2.454	4.118	3.086	5.017	4.778	4.580	3.663	3.095	4.156	3.700	4.693
Cr	ppm	1	4	8	1	1	5	1	1	1	29	1	5	30	1	1	1
Mg	%	2.64	2.67	1.90	2.00	3.87	2.26	1.94	2.35	2.99	2.98	6.28	2.36	2.14	2.86	1.83	2.38
Ba	ppm	3683	371	298	1200	285	1145	1418	345	1911	288	3250	637	1172	299	1601	723
Ti	%	0.01	0.03	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.02	0.01
B	ppm	422	272.5	307	297	630	360	340	447	419	360	581	312.5	442	320	332	382
Al	%	0.98	0.73	0.61	0.63	0.55	0.50	0.75	0.84	0.72	0.79	1.09	0.48	0.61	0.57	0.99	0.88
Na	%	0.07	0.20	0.25	0.64	0.53	0.35	0.31	0.12	0.15	0.13	0.10	0.11	0.46	0.12	0.28	0.35
K	%	16.95	12.46	13.60	15.19	20.02	14.92	17.32	19.62	17.49	21.69	18.92	16.05	17.88	13.27	13.69	19.32

Table 4a. Analytical data for ashed Balsam Fir

CANFIELDS CREEK TRENCH SURVEY - BALSAM FIR

TRENCH #		2	6	7	10
Cu	ppm	248	175	184	176
Pb	ppm	106	32	82	37
Zn	ppm	2181	1480	1652	1286
Ag	ppm	2.4	2.4	1.6	2.1
Ni	ppm	32	12	24	35
Co	ppm	8	3	5	3
Mn	ppm	18391	19382	24630	37466
Fe	%	1.33	0.24	0.51	0.38
As	ppm	10	5	6	11
U	ppm	14	7	5	5
Th	ppm	1	2	1	3
Sr	ppm	590	542	557	629
Cd	ppm	5.4	4.8	1.8	11.8
Sb	ppm	22	11	30	17
V	ppm	20	5	18	9
Ca	%	33.97	24.73	27.08	25.70
P	%	7.147	3.935	3.260	4.701
Cr	ppm	1	1	1	1
Mg	%	4.27	1.73	2.07	1.25
Ba	ppm	290	427	2641	917
Ti	%	0.05	0.01	0.02	0.01
B	ppm	430	283	331	326
Al	%	1.42	0.44	0.65	0.77
Na	%	0.48	0.23	0.30	0.23
K	%	26.69	14.46	17.18	17.25

Table 4a.
Analytical data for ashed Balsam Fir from the Canfields Creek survey.

CANFIELDS CREEK SURVEY - BALSAM FIR STANDARDS

		CDSTD1	CDSTD1	CDSTD1	CDSTD1	CDSTD1	CDSTD1	CDSTD2	CDSTD2	CDSTD2	CDSTD3	CDSTD3	CDSTD3
Cu	ppm	152	120	206	109	117	111	62	63	61	242	239	259
Pb	ppm	402	277	443	213	272	1528	44	40	41	548	546	601
Zn	ppm	2045	1989	1819	1748	1827	1774	133	134	134	2348	2293	2534
Ag	ppm	14.3	14.7	13.3	13.4	13.9	13.3	7.3	6.9	7.1	0.5	0.4	1.4
Ni	ppm	18	21	16	16	18	16	73	75	74	63	63	65
Co	ppm	3	3	3	3	3	3	32	32	32	10	11	11
Mn	ppm	15148	14391	14280	14118	14471	13876	1073	1084	1066	2568	2575	3492
Fe	%	1.52	1.39	1.26	0.87	1.29	1.22	4.00	3.96	3.97	1.16	1.28	1.22
As	ppm	3	6	5	2	3	2	42	39	43	18	19	21
U	ppm	5	6	5	5	5	5	18	16	21	5	5	5
Th	ppm	1	1	1	1	1	1	39	39	39	3	3	2
Sr	ppm	816	845	748	756	788	772	53	52	52	1201	1173	1239
Cd	ppm	4.7	4.5	3.7	4.2	4.8	4.9	19.0	18.5	18.9	12.5	12.9	12.1
Sb	ppm	3	6	4	8	4	7	15	15	15	7	4	8
Bi	ppm	4	2	2	2	2	2	20	19	21	2	2	2
V	ppm	5	5	5	5	5	5	60	55	57	26	27	26
Ca	%	29.23	25.98	27.99	28.10	29.06	29.38	0.49	0.50	0.49	32.36	31.31	34.75
P	%	1.086	0.870	0.961	1.081	1.006	0.944	0.098	0.092	0.094	2.331	2.077	2.310
Cr	ppm	10	8	3	3	10	4	57	58	59	23	22	23
Mg	%	2.87	2.82	2.52	2.59	2.80	2.65	0.89	0.89	0.89	2.61	2.58	2.86
Ba	ppm	351	183	643	561	359	540	187	182	185	391	381	425
Ti	%	0.04	0.04	0.04	0.04	0.04	0.04	0.09	0.09	0.09	0.03	0.03	0.03
B	ppm	312	325	295	299	304	297	33	34	34	412	404	442
Al	%	0.60	0.65	0.58	0.61	0.62	0.61	1.90	1.89	1.89	1.29	1.33	1.34
Na	%	0.40	0.38	0.34	0.34	0.36	0.35	0.07	0.06	0.06	0.11	0.11	0.13
K	%	6.01	5.42	5.50	5.51	5.75	5.59	0.13	0.13	0.13	2.35	2.32	2.63

Table 4b.
Analytical data for standards used in ashed Balsam Fir analysis (courtesy of C. Dunn).

CANFIELDS CREEK REGIONAL SURVEY - BALSAM FIR SAMPLE SPLITS

		SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT	SAMPLE	SPLIT
Cu	ppm	135	137	170	161	111	248	187	193	129	129
Pb	ppm	307	307	51	47	43	106	91	80	107	101
Zn	ppm	1903	1941	1015	959	1122	2181	2253	2502	1514	1525
Ag	ppm	1.6	1.6	1.8	1.6	1.4	2.4	2.8	0.2	1.3	1.6
Ni	ppm	27	20	19	16	21	32	43	29	16	16
Co	ppm	7	4	4	4	7	8	7	3	4	4
Mn	ppm	42965	42915	29218	28167	7845	18391	25816	27771	39744	38710
Fe	%	1.10	1.12	0.52	0.50	0.87	1.33	0.85	0.50	0.44	0.23
As	ppm	9	5	12	6	8	10	10	2	2	2
U	ppm	5	5	5	5	5	14	12	5	5	5
Th	ppm	2	3	2	1	1	1	3	1	1	3
Sr	ppm	596	608	532	499	300	590	601	694	492	489
Cd	ppm	9.3	9.9	6.8	6.8	3.0	5.4	4.8	1.4	9.7	10.1
Sb	ppm	9	18	54	18	12	22	33	11	2	5
Bi	ppm	2	2	2	2	2	2	2	2	5	2
V	ppm	16	16	12	10	14	20	19	5	13	10
Ca	%	13.29	13.75	28.21	25.78	16.41	33.97	17.80	18.43	26.63	25.59
P	%	3.448	3.565	2.556	2.409	2.650	7.147	4.992	4.229	4.413	4.480
Cr	ppm	15	14	1	1	1	1	1	1	1	1
Mg	%	2.37	2.37	2.00	2.00	1.99	4.27	2.40	2.64	1.59	1.57
Ba	ppm	628	711	1194	1200	1903	290	832	3683	2421	2356
Ti	%	0.04	0.04	0.02	0.02	0.03	0.05	0.03	0.01	0.02	0.01
B	ppm	304	309	307	297	218	430	376	422	321	326
Al	%	1.20	1.20	0.66	0.63	0.84	1.42	1.10	0.98	0.28	0.20
Na	%	0.27	0.28	0.61	0.64	0.21	0.48	0.14	0.07	0.11	0.12
K	%	15.22	15.39	15.74	15.19	11.73	26.69	15.82	16.95	13.30	14.09

Table 4c.
Analytical data for sample splits used in ashed Balsam Fir analysis.

CANFIELDS CREEK SURVEY - BALSAM FIR FIELD DUPLICATES

		SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	SAMPLE	DUPLICATE
Cu	ppm	201	211	122	151	141	138	174	178
Pb	ppm	89	68	22	24	78	62	98	96
Zn	ppm	2059	2227	1583	1696	1341	1392	1633	1602
Ag	ppm	2.7	3.5	1.3	1.7	2.1	2.4	2.2	1.6
Ni	ppm	38	44	18	21	24	22	27	21
Co	ppm	3	4	3	3	5	3	3	3
Mn	ppm	48279	34659	24169	35129	21624	22277	24723	20055
Fe	%	0.33	0.41	0.21	0.23	0.94	0.59	0.44	0.32
As	ppm	21	6	3	16	10	12	8	41
U	ppm	5	5	5	5	5	5	5	5
Th	ppm	1	1	3	3	3	2	2	1
Sr	ppm	587	446	534	555	389	434	497	535
Cd	ppm	16.6	11.2	2.7	2.5	8	9.2	6.1	17.3
Sb	ppm	357	7	8	125	13	13	12	417
Bi	ppm	3	2	2	2	5	2	2	2
V	ppm	3	9	4	5	20	12	19	11
Ca	%	20.69	18.48	17.46	18.08	18.70	19.52	22.52	21.99
P	%	4.563	5.470	3.671	3.654	4.001	4.180	4.050	4.043
Cr	ppm	1	1	1	8	6	2	2	13
Mg	%	2.91	3.06	2.09	2.62	2.61	2.73	1.82	1.98
Ba	ppm	3224	597	794	479	422	319	342	253
Ti	%	0.01	0.01	0.01	0.01	0.03	0.02	0.02	0.01
B	ppm	426	412	295	330	262	283	309	304
Al	%	0.71	0.73	0.51	0.44	0.81	0.64	0.67	0.54
Na	%	0.11	0.18	0.12	0.09	0.22	0.17	0.27	0.23
K	%	18.38	16.59	16.64	15.46	11.15	13.76	12.26	14.94

Table 4d
Analytical data for field duplicates used in ashed Balsam Fir analysis.

CANFIELDS CREEK REGIONAL SURVEY 1990 HUMUS

SAMPLE NUMBER		CC-90 1	CC-90 2	CC-90 3	CC-90 4	CC-90 5	CC-90 6	CC-90 7	CC-90 8	CC-90 9	CC-90 10	CC-90 11	CC-90 12	CC-90 13	CC-90 14	CC-90 15	CC-90 16
Cu	ppm	1	8	4	6	5	4	14	5	4	3	8	11	7	5	7	8
Pb	ppm	22	72	24	25	17	13	29	14	14	23	43	54	355	28	34	42
Zn	ppm	17	69	75	35	68	29	78	42	34	24	57	35	64	53	32	61
Ag	ppm	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Ni	ppm	2	5	5	6	5	6	9	7	6	4	5	11	4	6	3	7
Co	ppm	0.5	2	3	4	2	3	5	4	3	2	0.1	8	2	3	1	3
Mn	%	0.01	0.01	0.14	0.03	0.02	0.08	0.06	0.02	0.03	0.04	0.05	0.08	0.04	0.02	0.03	0.08
Fe T	%	0.46	0.49	0.72	1.05	0.55	0.66	1.32	1.01	0.98	0.51	0.33	1.05	0.39	0.74	0.18	0.56
Sr	ppm	2	12	36	2	14	9	18	4	5	12	13	26	13	6	20	16
V	ppm	6	9	10	10	8	11	11	10	12	7	8	6	7	7	9	10
Ca	%	0.03	0.23	0.47	0.04	0.35	0.26	0.59	0.11	0.21	0.25	0.33	0.44	0.09	0.09	0.44	0.30
Sc	ppm	87	190	227	107	131	182	348	89	215	207	74	18	79	112	268	205
Cr	ppm	3	5	5	5	4	6	9	7	8	3	4	5	3	5	2	5
Mg	%	0.03	0.08	0.11	0.11	0.08	0.12	0.24	0.15	0.14	0.07	0.07	0.09	0.07	0.11	0.07	0.10
Ba	ppm	48	252	116	35	76	91	160	36	55	127	147	226	71	56	226	141
Al	%	0.14	0.22	0.24	0.51	0.23	0.32	0.60	0.53	0.45	0.18	0.13	0.92	0.15	0.30	0.07	0.25
K	%	0.02	0.07	0.07	0.04	0.04	0.03	0.07	0.03	0.03	0.04	0.06	0.14	0.08	0.04	0.06	0.08

Table 5a. Analytical data for -80 mesh fraction of organic humus.

CANFIELDS CREEK REGIONAL SURVEY 1990 HUMUS

SAMPLE NUMBER		CC-90 17	CC-90 18	CC-90 19	CC-90 20
Cu	ppm	9	7	3	6
Pb	ppm	19	41	25	15
Zn	ppm	20	10	56	59
Ag	ppm	0.1	0.1	0.1	0.1
Ni	ppm	4	9	8	7
Co	ppm	1	3	5	5
Mn	%	0.03	0.03	0.07	0.06
Fe T	%	0.49	0.88	1.12	0.98
Sr	ppm	11	15	8	10
V	ppm	8	9	10	12
Ca	%	0.19	0.19	0.22	0.46
Sc	ppm	183	179	245	166
Cr	ppm	3	3	8	7
Mg	%	0.05	0.06	0.19	0.19
Ba	ppm	124	255	116	149
Al	%	0.21	0.34	0.50	0.41
K	%	0.03	0.05	0.05	0.04

Table 5a. Analytical data for -80 mesh fraction of organic humus.

CANFIELDS CREEK TRENCH SURVEY 1990 HUMUS

TRENCH #		1	2	3	4	6	7	10
Cu	ppm	4	3	4	4	3	14	3
Pb	ppm	15	14	13	18	10	30	9
Zn	ppm	31	43	38	46	35	47	21
Ag	ppm	0.1	0.1	0.1	3.2	0.1	0.3	0.1
Ni	ppm	8	6	8	3	3	8	3
Co	ppm	6	3	5	0.5	2	3	2
Mn	%	0.09	0.10	0.05	0.02	0.06	0.08	0.02
Fe T	%	1.18	0.89	1.07	0.07	0.57	0.45	0.53
Sr	ppm	3	7	4	27	8	16	4
V	ppm	10	11	11	0.5	7	7	7
Ca	%	0.08	0.25	0.12	0.24	0.23	0.61	0.09
Sc	ppm	185	189	159	128	145	14	85
Cr	ppm	9	5	8	3	3	4	4
Mg	%	0.18	0.14	0.18	0.09	0.08	0.10	0.05
Ba	ppm	44	90	54	73	117	124	41
Al	%	0.58	0.37	0.52	0.04	0.18	0.19	0.26
K	%	0.04	0.06	0.03	0.03	0.04	0.10	0.02

Table 5a. Analytical data for -80 mesh fraction of organic humus

CANFIELDS CREEK SURVEY - HUMUS STANDARDS

		STD-91-H	STD-91-H	STD-91-H	STD-91-L
Cu	ppm	1572	1566	1585	11
Pb	ppm	1417	1423	1412	21
Zn	ppm	9909	9613	9690	52
Ag	ppm	5.5	5.4	5.3	-0.2
Ni	ppm	15	16	15	15
Co	ppm	9	10	9	10
Mn	%	0.08	0.08	0.08	0.09
Fe T	%	2.75	2.79	2.68	2.41
As		575	549	555	8
Sr	ppm	12	12	12	14
Cd		42.8	41.9	42.9	-0.2
V	ppm	17	18	17	17
Ca	%	0.44	0.45	0.42	0.17
Sc	ppm	240	490	328	261
Cr	ppm	14	14	13	13
Mg	%	0.35	0.36	0.34	0.34
Ba	ppm	104	112	104	259
Al	%	0.99	1.03	0.96	0.76
Na		0.01	0.01	0.01	0.01
K	%	0.08	0.09	0.08	0.05

Table 5b.
Analytical data for standards used in the organic humus analysis.

CANFIELDS CREEK SURVEY - HUMUS ANALYTICAL SPLITS

		SAMPLE	SPLIT	SAMPLE	SPLIT
Cu	ppm	3	4	3	5
Pb	ppm	12	14	11	14
Zn	ppm	30	34	25	42
Ag	ppm	-0.2	-0.2	-0.2	-0.2
Ni	ppm	6	6	7	7
Co	ppm	3	3	4	4
Mn	%	0.03	0.03	0.02	0.02
Fe T	%	0.86	0.98	0.95	1.01
As		-5	-5	-5	-5
Sr	ppm	4	5	4	4
Cd		-0.2	-0.2	-0.2	-0.2
V	ppm	10	12	10	10
Ca	%	0.18	0.21	0.10	0.11
Sc	ppm	176	215	183	89
Cr	ppm	6	8	7	7
Mg	%	0.12	0.14	0.14	0.15
Ba	ppm	47	55	35	36
Al	%	0.39	0.45	0.50	0.53
Na		-0.01	-0.01	-0.01	-0.01
K	%	0.03	0.03	0.03	0.03

Table 5c.
Analytical data for sample splits used in the organic humus samples.

CANFIELDS CREEK SURVEY - HUMUS FIELD DUPLICATES

		SAMPLE	DUPLICATE	SAMPLE	DUPLICATE	SAMPLE	DUPLICATE
Cu	ppm	10	5	4	6	4	5
Pb	ppm	56	29	28	27	14	14
Zn	ppm	88	25	39	67	34	42
Ag	ppm	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Ni	ppm	5	4	8	4	6	7
Co	ppm	-1	1	4	2	3	4
Mn	%	0.06	0.03	0.02	0.02	0.03	0.02
Fe T	%	0.28	0.38	1.01	0.47	0.98	1.01
As		-5	-5	-5	-5	-5	-5
Sr	ppm	16	9	4	8	5	4
Cd		0.3	-0.2	-0.2	-0.2	-0.2	-0.2
V	ppm	9	6	8	5	12	10
Ca	%	0.46	0.20	0.06	0.12	0.21	0.11
Sc	ppm	17	130	108	116	215	89
Cr	ppm	4	4	7	3	8	7
Mg	%	0.07	0.06	0.15	0.06	0.14	0.15
Ba	ppm	169	125	33	79	55	36
Al	%	0.11	0.15	0.38	0.21	0.45	0.53
Na		-0.01	0.01	-0.01	-0.01	-0.01	-0.01
K	%	0.07	0.05	0.03	0.04	0.03	0.03

Table 5d.
Analytical data for field duplicates used in the organic humus analysis.